Popular Science Talks

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SEASON OF 1929

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FOREWORD

The lectures which constitute this, the Seventh Annual Volume of Popular Science Talks, represent the effort of the Philadelphia College of Pharmacy and Science to contribute to the educational welfare of the community at large by means of popular scientific discussions.

These lectures are given annually by members of the Faculty of the College and cover a broad and interesting field of scientific subjects. They are not arranged in a course covering any particular field of science, nor is there any interdependence or connection between them. They are presented in a non-technical, easily understandable form, but without the sacrifice of scientific accuracy or completeness. Usually they are illustrated by appropriate experiments, specimens or lantern slides.

Following the second year of the presentation of these Popular Science Lectures by the College a demand arose for the lectures in book form, in spite of the fact that most of the lectures had appeared in the American Journal of Pharmacy following their presentation.

This demand has been supplied for the past six years and the following volumes with their lecture subjects are available at a cost of $1.00 per individual volume, through the American Journal of Pharmacy, Forty-third and Kingsessing Avenue, Philadelphia.

Volume I includes twelve lectures as follows: "Chemistry as an Aid in the Detection of Crime," "Corn and Its Products," "The Story of Glass," "Bacterial Preparations," "Another Drop of Blood," "The Romance of Spices," "Catalysis and Catalysts," "The Aluminum Age," "Animal Eating Plants," "Explosives and Explosions," "The Making of Medicines," "Iron and Iron Alloys."

Volume II includes eleven lectures as follows: "Invisible Light," "The Story of Rubber," "Chemistry in and About the Home," "Idiosyncrasies, or the Story of a Sneeze," "What is Chocolate?" "Sugar as a Medicine, Food and Poison," "Social Insects," "The Romance of Drugs," "Something About Gases," "Household Insect Pests," "Drugs of the North American Indians."

Volume III includes thirteen lectures as follows: "Arctic and Tropical Pennsylvania," "The Romance of Chemistry," "Chemistry

and Color," "The Mineral and Vegetable Resources of the Sea," "Chemistry in and About the Home," "The Ups and Downs of Nitrogen," "Animal Aviators," "Practical Disinfection," "Why Soap?" "What Shall I Eat?" "Bridge Construction," "Chalk and Its Chemical Relatives," "Control of Growth in Plants and Animals."

Volume IV includes twelve lectures as follows: "The Romance of Medicine," "More About Color and Colors," "Coal and Coal Mining," "Environment—The Big Factor in Health and Disease," "Imitation of Life," "The Sign of the Skull and Cross Bones," "Delectable Confections," "The Flight of a Ball Through the Air," "The Diamond and Its Colored Brethren," "What Shall I Drink?" "The Salt of the Earth," "Abnormal Plant Growths."

Volume V includes eleven lectures as follows: "Paper," "The Romance of the Occult," "Epochs and Epoch Makers of Medicine," "The Story of Burnt Clay," "Hormones, Vital Substances in Life," "Epidemics, Man's Most Deadly Enemy," "My Lady Nicotine," "Sand From Mountain to Seashore," "What Shall I Wear?" "Why the Weather?" "Mosses and Their Message."

Volume VI includes twelve lectures as follows: "The Romance of Cookery," "The Heart," "The Realm of the x-Ray," "Building Stones," "The Preservation of Foods," "What and Where Are the Stars?" "Sumac and Poison Ivy," "Ice—Wet and Dry," "The Rare Elements," "European Flowers in Commerce and Culture," "Flame," "Animals That Live in Man."

The new series arranged for this year (1930), a list of which appears at the end of this volume, will be found to include an entirely different array of subjects from that of any previous season.

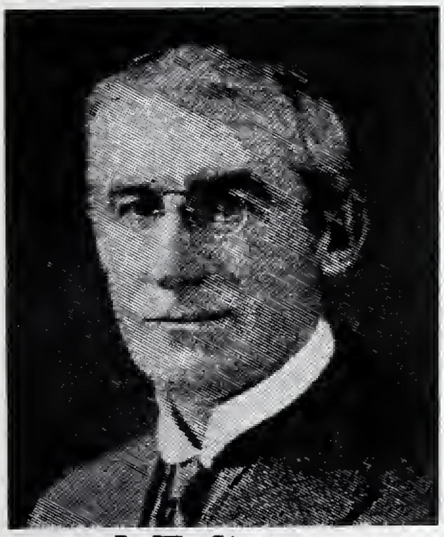
THE MODERN SUN CULT

By J. W. Sturmer

Dean of Science, Philadelphia College of Pharmacy and Science

SUN-ENERGY

IN THE SPRINGTIME all vegetation awakens to renewed life. This transformation would be most astonishing if its annual recurrence had not taught us to accept it as a matter of course. The advent of the growing season which comes with unfailing regularity, is the result of more sun-energy, that is, more light, and with it, more heat rays which we can feel yet cannot see, and more, also, of that mysterious radiation which we can neither feel nor see, but which we now know to be a potent agency affecting all living creatures, namely the ultra-violet rays.



J. W. Sturmer

Our house plants have the habit of growing toward the sun, and we ourselves intuitively seek its light and warming rays. No physician need order us to do it; it is simply natural that we crave sunshine. Under its influence we are alert, active, optimistic, cheerful. When great lowering clouds hide the sun from us, we are apathetic, lethargic and gloomy. "Diogenes", asked Alexander the Great, "what can I do for you?" "What boon would you beg of the all-powerful conqueror of nations?" "Step aside, Alexander", answered the old philosopher, who was not noted for tact or courtesy. "Step aside, and do not shut out my sunlight."

WINDOWS OF GLASS AFFECTING HEALTH

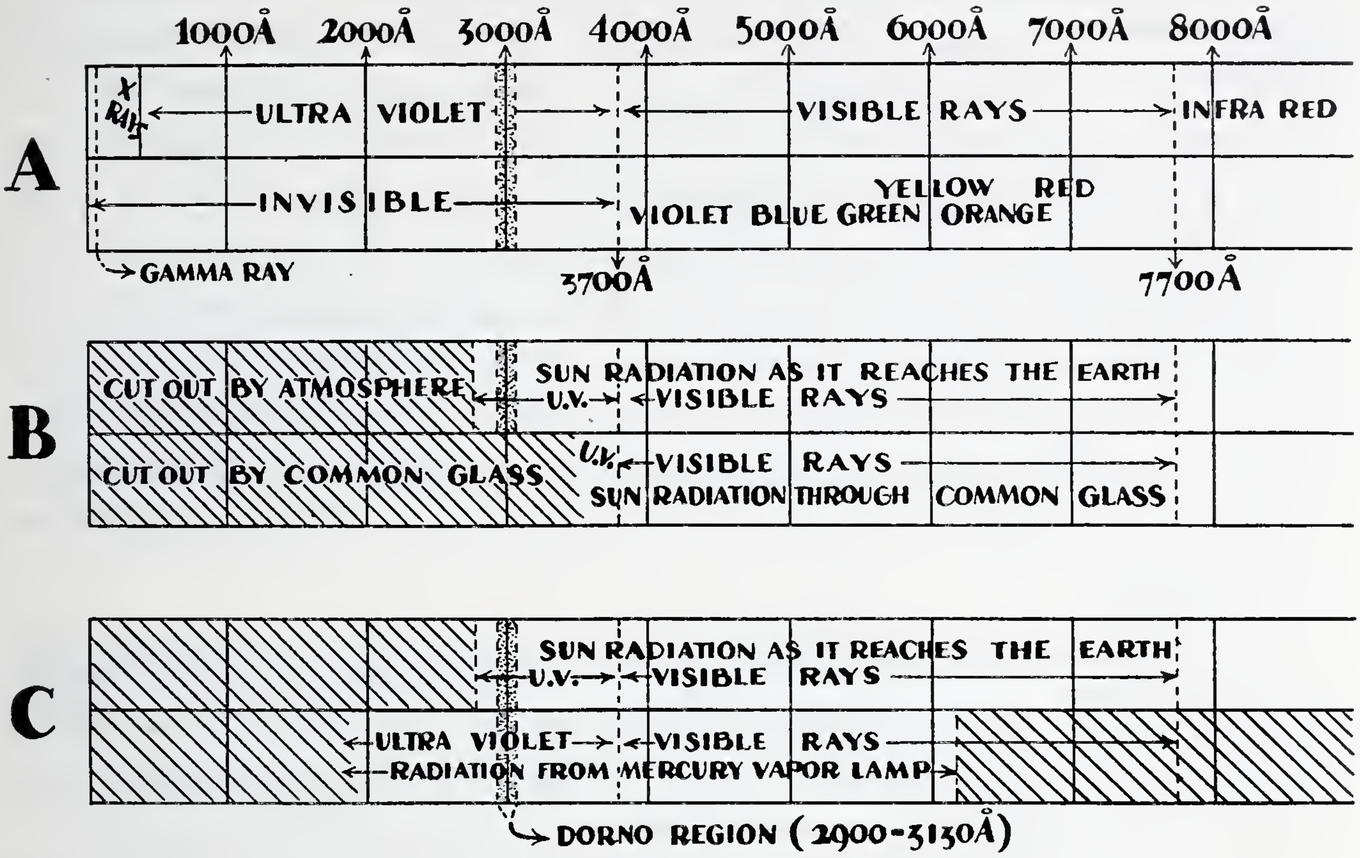
Primitive man was at one time a cave dweller. His house was dark. There were no windows. But the chances are that he was at home but little, that he lived largely in the open, and that only when the weather was extremely inclement did he take refuge in the dark hole in the rock which he called home. It is highly probable also that when the season permitted it, his apparel was not more extensive than a modern sun-suit. We may be sure that he got his ultra-violet pretty generously, as did also his spouse and children. Unquestionably man

is an out-of-door creature intended to live in the sunlight. And for thousands of years he so lived. But a few centuries ago a marvelous transparent substance was discovered, namely glass, and this discovery has in a marked degree changed the human habits of life and of work, for the cold months are now spent largely indoors, behind this glass, which shuts out the wintry winds, but transmits sunlight, and with it some of the warmth of winter-sunshine. Unfortunately, however, and this was unknown until quite recently, glass does not transmit all the kinds of sun-energy which we need, for the rays of shorter wave lengths than those of light are in large measure intercepted by glass and so these rays now fail to reach us. Thus we receive in our homes, and even on our sun-porch, a vitiated and abnormal sun radiation—a radiation which has lost something, something imperceptible to our organs of vision, but which we require for our physical well-being.

EFFECTS OF SUN ACTIVITY

The sun is about 93 millions of miles distant. Its enormous mass exhibits tremendous chemical activity, and it is radiating its substance—so scientists inform us—at the rate of several million tons per second. The sun-radiation thus engendered streams into space and only a relatively small per cent. of it reaches the planet on which we live. Yet, as this small portion of the total varies, we experience winter or summer, great heat or extreme cold: our vegetation flourishes or dies; our hills are green, or they are white with a covering of water crystals from the skies; our continent experiences a glacial period, or an age of tropical warmth.

The sun-radiation vaporizes the waters on the earth and forms clouds, fog and rain. It stirs up the atmospheric mantle which surrounds our planet and causes winds to blow—gentle spring zephyrs, or devastating tornadoes. It develops the green and the yellow pigments in leaves and the riot of colors in flowers. It also makes the vegetable cell function as a chemical laboratory in which water and the carbon dioxide of the air form plant substance, and thus our plants grow, producing our food, our shelter and our raiment. Even our fuels, gas, coal and oil, have a sun-energy origin, and the modern cliff dweller in his steam-heated apartment, reading his newspaper under the incandescent Mazda, gets light which originated in the sun, no matter whether the electric current he uses is generated from coal or by water power. We are warmed by the sun, fed by the sun, and clothed by it, just as was primitive man, ages before us.



A. The radiation designated as ultra-violet comprises the wave-lengths ranging from the x-rays to the visible spectrum, which begin at about 3700Å. The visible rays extend from this point, which is sometimes given in round numbers as 4000 Å to about 7700 Å. Then follow the penetrating infra-red rays, up to about 1400 A, and beyond these the long-wave infra-red rays, lacking in penetrating power and known as ordinary heat rays. The ultra-violet range may be divided into three zones: The first zone, up to waves of about 2000 Å are rays at present of scientific interest rather than of practical application, but are known to be dangerous. The next zone, from 2000 Å to about 3000 Å, comprises the bactericidal rays, the germ-killing power being strongest between 2380 Å to 2490 Å. Beginning at about 2800 Å and extending to the visible violet (about 3700 Å), we have the health rays, the ultra-violet which comes to us in sunshine. From 2800 Å to 3300 Å the rays have pigmenting effect—can produce tan or freckles, depending upon the development of a skin pigment called melanin. But only the rays from 2890 Å to 3130 Å can develop vitamine D in the human skin. This is the Dorno region. Hence the rays from 2800 Å to 2890 Å and those from 3130 Å to 3300 Å can produce tan without developing vitamine D, and a transmitting medium which permits the passage of rays producing tan is not necessarily satisfactory from the health standpoint.

B. The rays of the Dorno region are filtered out of sunshine by common glass. But these rays are not necessarily shut out completely if the radiation is of great intensity as it may be had from a powerful ultra-violet lamp. The thickness of the glass must, moreover, be taken into consideration. A glass which shuts out the Dorno rays from sunshine may transmit them partially as they are emitted from a lamp.

C. Ultra-violet lamps differ not only in the range of wave-lengths which they provide, and in the intensity of total radiation, but also in the relative intensity of the wave-lengths within the Dorno region as against the other ultra-violet rays produced. Lamps are tested, compared and standardized by means of the Dorno Cadmium Cell, an electrical contrivance the construction of which is based upon the sensitiveness of cadmium to the wave-lengths from 2890 Å to 3130 Å.

WHAT IS SUN-ENERGY?

Now what is it that the sun sends to us through 93 million miles of space? Is it a stream of electrons? So it would appear. But we had better not be dogmatic on this subject which is linked with the fundamental concepts of energy and matter—concepts which have been modified quite recently, and may soon be modified still further. Most physicists now subscribe to the corpuscular theory, in accordance with which light, and the ultra-violet and the heat rays as well, come from the sun as a stream of corpuscles, emitted in a succession of bursts, but the latter so close together, and following one upon the other with such inconceivable speed, that the stream is, as far as we can perceive, continuous and unbroken.

WAVE-LENGTHS

When, however, solar radiations are to be dealt with in their practical aspects, as for instance in regard to reflection or refraction, it is the other theory of light, the wave theory, that provides the nomenclature. So we continue to speak of wave-lengths, and of wave frequencies, just as we do in radio parlance. Indeed, it is generally accepted that certain light waves may be "tuned in," and other light waves refused entry. On this basis we explain the phenomenon of color. But to understand the explanation we must remember that the light waves of the different colors of the spectrum differ in length; that the red waves are the longest, and that the waves become shorter and shorter, through the orange, yellow, green, blue, and violet, the latter being less than half the length of the red.

ULTRA-VIOLET

It must not be assumed that ultra-violet rays are of a single wave-length. On the contrary, they embody a range of wave-lengths, just as light rays represent a range. The longest waves of ultra-violet are just a little shorter than the shortest violet waves. They are thus just *beyond* the violet-rays of the spectrum. Hence the term *ultra*-violet. It is not quite correct, however, to speak of ultra-violet light, for light is visible, while the rays of shorter wave-lengths than those of light are invisible. Hence we had better use the term ultra-violet radiation.

THE ANGSTRöM UNIT

We must bear in mind that the waves of light rays are exceedingly minute—too short to be measured by ordinary methods, and that we cannot conveniently express such infinitesimal lengths in fractions of inches or even of millimeters. And as the waves of ultra-violet rays are shorter still,

the necessity for a special unit of length to be employed in the measurement of such minute waves is obvious.

The unit most generally used is called the Ångström unit, and was so named in honor of a Swedish physicist by the name of Ångström. It is a metric unit, and represents $\frac{1}{10,000,000}$ of a millimeter, the millimeter being equivalent to about $\frac{1}{25}$ of an inch. Now in terms of this unit visible light ranges from about 3600 Ångström units, (Å), to about 7700 Å—although it must be remembered that the human organs of vision vary in their range, and that many persons cannot see the rays of wave-lengths as short as 3600 Å, nor those of wave-lengths as long as 7700 Å.

WAVE-LENGTHS OF ULTRA-VIOLET

Wave-lengths shorter than 3600 Å, and down to about 1000 Å, constitute the ultra-violet radiation. The shorter the waves, the higher the frequency, that is, the larger is the number which pass a given point in a unit of time. All solar radiation travels at the same inconceivable speed of about 186,500 miles a second, thus being capable of encircling the earth more than seven times in that short period. This applies to ultra-violet as well as to visible light, just as it does also to the very long waves which carry our radio programs. This means that the rays from ultra-violet lamps reach us so speedily—if they are not absorbed by an intervening medium—that we have no time to side-step them, even though we may stand at some distance from the lamp. We can protect ourselves only by the use of an intercepting medium.

The radio waves, many city blocks in length, the infra-red, visible light, ultra-violet, and X-rays, all seem to be fundamentally the same, except in the matter of wave-lengths and conversely in the rapidity with which the waves follow one upon the other; but by virtue of this variation they exhibit a most decided difference in penetrability and in their action on inanimate objects and on living organisms.

SOURCE OF ULTRA-VIOLET

An ordinary wood or coal fire emits light and heat rays, but no appreciable ultra-violet radiation. If, however, carbon disulphide is burned in a stream of oxygen, the flame which exhibits intense white light, emits also ultra-violet radiation. So ordinary combustion can be the source of these mysterious rays. But carbon disulphide is a substance both dangerous and malodorous, and its use in lamps for the production of ultra-violet is limited to laboratory experiments.

ULTRA-VIOLET LAMPS

The practical ultra-violet lamps are types of electric lamps. This applies to those which are used for strictly scientific purposes as well as to the lamps now so largely sold for family use for the irradiation of the human body. To be sure, the lamps for scientific purposes are designed to furnish a greater intensity of radiation, and one embodying a wider range of wave-lengths. They are also provided with filters to intercept the light waves, which is not a necessity if the lamp is to be employed for therapeutic purposes, as for such uses the accompanying light waves seem to be desirable and certainly not objectionable.

Structurally the lamps may be divided into two classes: the exposed arc lights, and the lamps in which the radiation is produced within a bulb or tube. The principle upon which the majority of ultra-violet lamps are constructed is that an electric spark sent through the vapor of certain metals—iron, nickel, zinc, mercury, etc.—produces this radiation.

A common form of the arc type has carbon electrodes with metallic cores, or cores impregnated with metallic ingredients. But also carbons without metallic ingredients may be used, in which case a very wide arc (about two inches) is employed.

The other kind of lamp (always with a bulb or tube) is known as a mercury vapor lamp. Such a lamp may have electrodes of mercury, or these may be of some other metal, such as tungsten; but in either case the gap between the electrodes is occupied by mercury vapor which the current traverses and causes to glow with a greenish light, the invisible ultra-violet rays being produced with the light waves. The light from such a lamp does not include the longest visible waves, that is, it is devoid of the red and orange; and as a consequence the light is colored, for white is obtained when all the wave-lengths of the red, orange, yellow, green, blue and violet are produced. The lamps used for therapeutic purposes may be arc lamps or mercury vapor lamps, but for scientific use the latter type of lamp is usually preferred.

A common form of mercury vapor lamp is essentially a specially constructed quartz tube, exhausted of air, and containing liquid mercury which may be made to separate, and thus an arc may be struck. The wires are connected in such a manner that the spark must jump from the one body of mercury to the other, thus traversing the gap occupied by mercury vapor.

Quartz is employed for the tube or bulb because of its remarkable transparency to ultra-violet rays, permitting penetration of wave-

lengths as short as about 1850 Å. Only calcite and fluorspar are known to transmit yet shorter wave-lengths. For the lamps designed for therapeutic use, quartz need not be employed, as such lamps are planned to furnish only the ultra-violet rays of wave-lengths greater than 2900Å, these being the rays which come to us in sunshine. Thus a special kind of glass may be made to serve for the tube or bulbs, and the employment of quartz is not necessary for family sun lamps. Lamps embodying bulbs or tubes are known to become less efficient with use. This progressive loss of efficiency is largely due to changes which the radiation effects in the quartz or glass, probably a gradual de-vitrification, and a discoloration because of the deposition of particles by sublimation.

FILTERING OUT LIGHT WAVES

The filters used to cut out the light waves, so that only the ultra-violet may be transmitted, are either plates of quartz on which a thin film of silver has been deposited, or they are glasses deeply colored with certain metallic ingredients.

THE INVISIBLE BECOMES VISIBLE

When the invisible ultra-violet rays, unaccompanied by light rays, are caused to fall upon certain objects, an astonishing phenomenon may be observed. Objects which in common light have color, may change color; and objects which are commonly colorless, may exhibit color—may show red, orange, yellow, green, blue, or violet—any color of the spectrum. Thus, the fingernails, the teeth, and the eyeballs, glow with a pale yellow light. A crystal of calcite looks like a coal of fire; a crystal of fluorite shows a beautiful violet-blue. The zinc ore called Willemite, glows brilliantly with a yellow-green light. Indeed, many chemicals, in ultra-violet light, show characteristic color-effects. Thus, calomel, exhibits a brick-red color, sodium salicylate is violet-blue, quinine, violet; petrolatum, light blue. The explanation of such extraordinary effects is that these substances, and many others which show color under ultra-violet, have the property of reducing the latter radiation to longer wave-lengths, effecting a step-down, as we might call it, and thus bringing the rays within the range of the visible spectrum.

FLUORESCENCE

This phenomenon is called fluorescence, because it was observed first in the mineral fluorite.

Not only the color, but also the intensity of the fluorescence, varies greatly. Thus, for example, both sodium and potassium

salicylate show a violet-blue; but the fluorescence of the sodium salt is much more pronounced. Again some solids which show little or no fluorescence, may develop it to a marked degree when they are dissolved in an appropriate solvent. The examination of substances under ultra-violet is a new development in science, and one which gives promise of many applications in solving problems in practical chemistry.

Certain substances fluoresce with a red light, that is to say, they step down the invisible rays to about 7000 Å. If the waves coming from the chemical when it is subjected to ultra-violet are mostly waves of about 5500 Å, these will appear to our eyes as green; and so on through the range of colors which are seen in the rainbow. But we must remember that just as visible light represents not a single wave-length but a range from about 7700 Å to about 3600 Å, so does ultra-violet radiation represent a range of wave-lengths, beginning where the shortest waves of the visible spectrum end, at about 3600 Å, and diminishing in length to about 1000 Å. Immediately beyond the ultra-violet there lies an unexplored field; and then, farther on, in the neighborhood of 100 Å there are the X-rays concerning which we have some definite knowledge. And, lastly, beyond the X-rays, come the shortest waves known to science, the gamma-rays, from radium, and beyond these the cosmic rays about which we now are receiving rather startling information.

ABSORPTION OF ULTRA-VIOLET

We are all familiar with the fact that some substances, like soot, absorb all the rays of common light, and hence appear black, while other substances reflect indiscriminately all the wave-lengths of light, as does this paper, and hence appear white. We know also that many substances exhibit selective absorption, failing to appropriate the red, the yellow, the green, or the blue, and thus possess the colors of the wave-lengths which are not absorbed.

Now ultra-violet, speaking generally, is much less penetrating than the longer waves which we can see, and this feeble penetrability diminishes more and more as the wave decreases in length. The opacity of most known substances to the ultra-violet radiation has tended to make its study difficult, and it was not until the technique of making quartz glass had been perfected that much headway could be made. But in fused quartz we have a medium transparent to waves as short as 1850 Å. For the study of still shorter waves certain minerals,

namely fluorite and calcite, are employed. But the waves shorter than 1850 Å have at present no practical application, so the quartz glass serves very acceptably.

THE WAVE-LENGTHS WHICH PASS THROUGH THE ATMOSPHERE

Solar radiation is rich in ultra-violet. Just how rich, and what its range of wave-lengths may be, we do not know, perhaps shall never know, for our atmosphere, even when it is clear, cuts out all the wave-lengths shorter than those of about 2900 Å. What is known concerning the shorter waves has been learned through the study of radiation artificially supplied by arc lights and lights from sparks through metallic vapors.

ULTRA-VIOLET THROUGH GLASS

Common glass transmits only the longest waves of ultra-violet radiation, those which are longer than about 3400 Å, and hence are in the neighborhood of the visible violet light waves. This explains why a sunporch furnishes impoverished sunlight. But in recent years special kinds of glass have been made, designed to transmit the solar ultra-violet more generously. The claim is made that this glass transmits about 65 per cent. of the invisible active rays, a statement which requires explanation. The facts are these: not 65 per cent. of all the ultra-violet waves of sunshine pass through in the same proportion in which they occur out of doors, but rather 65 per cent. of the radiation, with a much greater absorption of the shorter waves—even a total absorption of some of them—and a lesser interception of the longer ones. In other words, these so-called ultra-violet transmitting media do cut out an appreciable amount of the wave-lengths shorter than about 3000 Å.

THE DORNO REGION

The significance of the interception of wave-lengths shorter than about 3000 Å by the special glasses, and of all wave-lengths below about 3300 or 3400 Å by common glass is better understood when it is known that the rays which produce the beneficial effects on the human skin connected with the production of vitamine D are those of wave-lengths from 2900 Å to 3130 Å. This region of the ultra-violet range of wave-lengths is known as the Dorno region, and embodies the rays used therapeutically. These are the rays which are desired chiefly also in the radiation from the ultra-violet lamp. Rays of wave-lengths from 2800 Å to 3300 Å are kown to produce pigment, but particularly

is this effect said to be due to the wave-lengths of the Dorno region. It appears that tanning is nature's protection against too much ultra-violet radiation of the wave-lengths which cause the chemical changes in the skin, for when the tan has become deep enough, the Dorno rays no longer penetrate, but are absorbed by the pigment and changed to heat rays.

WINDOWS

Window panes of quartz glass, SiO_2 give, of course, the best results in the transmission of the ultra-violet of the Dorno region; but only quite recently has the manufacture of quartz window panes been placed on an industrial basis, and unfortunately the price is still too high to admit of their general employment in the windows of solaria. The other types of ultra-violet transmitting glass, though not as satisfactory, are much cheaper. A still cheaper substitute is celophane, which is essentially a transparent sheet of cellulose. This substance transmits the radiation quite well, but it lacks durability, and requires a specially constructed frame.

DOSAGE OF SUNSHINE

How much sunshine do we need? Sunshine, like heat, food, or medicine, or any other agency which affects us, must be taken in proper apportionment. There is such a thing as too much food. Certainly, such a thing as too much calomel. That too much heat hurts us, we learn in early childhood. Sooner or later we learn also that too much sunshine is harmful. And an extensive and deep sunburn is not only painful, but like any other burn, is dangerous, resulting in cell destruction, with the generation of toxines, which cause systemic poisoning. Thus even sunshine must be taken in proper dosage. Fortunately, however, sunshine does not ordinarily harm us if we accustom ourselves to it gradually, and thus avoid sunburn. This remark, however, applies only to persons who are well, for in certain diseases even strong sunshine may be detrimental.

PROTECTION AGAINST ULTRA-VIOLET

If we are interested in protection against ultra-violet rather than in its transmission, we need but remember that substances which allow only the longer waves of the visible spectrum to pass—amber glass, red glass, orange and yellow glass—will prove opaque to ultra-violet, while a medium which cuts out the red end of the spectrum and transmits the violet and blue, will prove to be rather transparent also to the adjacent invisible waves just beyond the violet. Thus blue cobalt glass trans-

mits some ultra-violet, while red glass and amber glass filter it out, together with the short wave radiation of the visible spectrum, namely the violet, blue and green.

It will be seen, in the light of this fact, that the practice, formerly in vogue, of keeping the light-sensitive chemicals in blue glass bottles, was a misguided procedure, destined to prove ineffectual, while our present-day practice of employing amber glass, is founded on sound principles and is much more effective.

Another means employed to shut out ultra-violet is to interpose a fluorescent substance as a protective, for such a substance will transform this radiation into visible light waves. The cold creams and ointments specially devised to protect against sunburn are compounded on this principle, and contain fluorescent material. Even the ointment bases are fluorescent.

That sunlight deleteriously affects house paint is well known, and we have all observed how much longer paint lasts on the north side than it does on the southward exposure. The inclusion of a fluorescent material is, therefore, of benefit in house paint. Now zinc white is such a substance, and its employment in the paint materially lowers the penetration of the ultra-violet rays which are so destructive to the linseed oil binder, causing the oxidized oil to disintegrate to powder, thus bringing about the result which the painter refers to as "chalking." Most face paint, also, is somewhat fluorescent, and is to some degree a protection against sunburn.

CLOTHING AND ULTRA-VIOLET

A few remarks about clothing may be relevant in this connection. A person exposed to the ultra-violet in connection with electric welding may receive a burn through his clothing. This is due to the intensity of the radiation. But most clothing effectively intercepts the light rays and also the ultra-violet radiation of sunlight. Animal hair is quite opaque to solar ultra-violet. Only very white hair transmits it to a slight extent. This means that all woolen clothing is an effective ultra-violet filter, and that the modern male, promenading on the boardwalk receives practically no such radiation through his clothing. Silk also is fairly opaque, linen a trifle less so, while cotton is a bit more transparent. The most transparent textile is a loosely-woven rayon or artificial silk, which explains why the sex known during the Victorian Era as the weaker sex is on the way to becoming the robust sex. The girls are getting more solar radiation, hence more vitamine D. This in part

explains it. I would not be guilty of a breach in tact and criticize feminine raiment, which by the way would be futile, for I know that in the past neither the facts disclosed by science, nor the admonitions of the medical profession, have had any influence on the fashions of dress. Hence it is probably fortunate that I have warrant for the statement that the feminine dress of today is in far closer harmony with the newer facts pertaining to irradiation as a health measure than is the modern attire of the male. Women have gone far, since Civil War days, in so changing the fashions as to provide for plenty of sun irradiation; and in this span of time the men, alas, have made progress merely to the extent of having shaved off their whiskers, and exposing their chins to the sun. Only on the beach at the seashore does the pipe-smoking sex get an even break when it comes to solar radiation. What should be done about this is a matter far beyond the scope of this discussion. We give it up.

SUSCEPTIBILITY TO SUNBURN

The human skin varies considerably in its tolerance of solar radiation. Light-skinned persons are more sensitive to it than are the dark-skinned, and in most individuals a tolerance may be slowly developed by progressively increasing doses—if one may use the term doses in this connection. Speaking generally, our arms can stand about half again as much as the chest, abdomen or back; the legs a little more than the arms, the backs of our hands about five times as much, and the palms about fifteen times as much, while the foot soles are most resistive, because here the skin is thickest, and the outer skin is a poor conductor of radiation. But persons who do not tan must be very careful in taking sun baths.

BURNS BY REFLECTED RAYS

A sunburn, unlike a heat-burn, does not become manifest instantly. We may receive an overdose of sun radiation and remain oblivious of the fact for three or four hours. Nor is it easy to judge how long we may with impunity subject ourselves to sunshine at any given time, for so much depends upon the time of day, the season of the year, and the atmospheric conditions. We should know, however, that not only the direct rays burn, but that diffused sunlight, and reflected radiation, does also; that, for example, we may sit in a boat under an awning and receive a burn. It should be borne in mind that much of our ultra-violet comes to us reflected from the sky, and that the north exposure of our house provides about half as much as the exposure facing the sun.

VARYING INTENSITY OF SUNLIGHT

It may, further, help us to guard against sunburn if we remember the fundamental fact that the lower strata of our atmosphere are particularly absorptive toward ultra-violet, much more so than the more rarified strata higher up, the curve of ultra-violet in sunshine being virtually identical with the arc described by the sun in its course from horizon to horizon, which explains why old Sol is so much more powerful near the middle of the day, and much feebler when in the morning and evening its rays travel a longer distance through denser strata. It is indeed a common observation that at sunrise and at sunset even the violet and blue of the visible spectrum is largely cut out, giving us a preponderance of reddish and orange light. And as a matter of fact, the ultra-violet is almost wholly intercepted at the same time.

WINTER-SUNSHINE

In the winter, the sun is not so high in the sky, and its slanting rays are for this reason relatively poor in ultra-violet, just as are those of the morning and evening sun. Furthermore, there may be fog, clouds and soot particles, all of which filter out the shorter rays. Soot is the greatest offender in this respect, and does much to deplete still further the enfeebled sunshine of the cold season of the year. Our industrial centers naturally suffer most in the matter of vitiated sunlight, for in order that we may keep warm, and that our wheels of industry may be kept spinning, immense quantities of soot are belched forth from our chimneys.

DEFICIENCY OF ULTRA-VIOLET

In other words, we are systematically sacrificing the short wave solar ultra-violet in order that we may have an abundance of the longer waves which keep us warm. Only in very recent years have we learned about the unhealthfulness of this practice, and have come to the conviction that something must be done about it. A paucity of solar radiation means, so medical men tell us, a slackened metabolism, an enfeebled condition, a lowered resistance to germ diseases. It has in fact been suggested that the gradual extinction of certain Indian tribes may be due largely to their altered dress, and their changed modes of life, resulting in inadequate sun-irradiation, which is so necessary to them. In children, regardless of race, too little sunlight may mean rickets, or tuberculosis; and it was indeed in the treatment of these diseases that solar radiation was first employed in a systematic way. The sun-cure is not, however, in reality modern, for Antyllus, a physician of

ancient Rome, made use of it, and he practiced heliotherapy long before anything was known about vitamine D. It is interesting to know also that rickets is the disease which he treated with sunlight. But since his day much definite information has been brought to light, some of it by feeding experiments conducted with animals, both in the absence and in the presence of radiation. Curative procedures also have been engaged in, experimentally, an animals, and clinically on patients in hospitals.

VITAMINE D

It is now known that when the skin is irradiated with ultra-violet, pigmentation or tanning is not the only result. Far more important is the change experienced by a certain chemical substance in the skin, a substance which becomes activated to form a vitamine, namely, the vitamine now designated as vitamine D, which appears to be just as essential to the proper functioning of the human organism as is certain mineral matter which it is well known, we must supply in our diet. If, then, we receive, because of our abnormal modern conditions of life, too little sun radiation, the tiny laboratories in our skin fail to elaborate an adequate supply of vitamine D, and as a result, the life functions fail to go on normally and as they should, even though we may not develop a recognizable disease.

BOTTLED SUNSHINE

We may in such cases proceed in a manner suggested by the serum treatments. We may obtain from another living organism the substance which we fail to produce ourselves. If we cannot develop our own vitamine D, we may buy it, and take it as medicine or food. Now the codfish, and other fish also, possess an abundance of vitamine D, the source of which appears to be the marine algæ, which are eaten by shrimp and small fish, which in turn supply the vitamine much against their will to the larger fish. The vitamine D in fish is found principally in the liver, and it occurs in the oil expressed from fish liver. So cod liver oil has come to be known as "bottled sunshine" useful in the treatment of the diseases which develop because of an inadequacy of solar radiation.

HOW MUCH SUNSHINE IS ENOUGH?

But what amount of such radiation and how much ultra-violet is adequate? We do not know. Physicians recognize the diseased conditions which follow a dearth of sunlight but they cannot tell us precisely how much we must have. Hence we do not know how long we must

be in the sunlight, how great an area of our body surface must be exposed to it, nor how long we can go on without irradiation. But we do know that in the winter at least we do not receive as much as we need.

SUNLIGHT CANNOT BE STANDARDIZED

As the ultra-violet rays in sunlight vary not only according to the season and the time of day, but also according to atmospheric conditions it is utterly impossible to determine with any degree of accuracy the dosage of sunlight needed in specific cases. Hence the helio-therapist has learned to proceed cautiously and experimentally. A sun-bath of an hour may be safe enough on a certain day, but may, at the same hour, and in the same length of time, on the day following, cause a severe sunburn. One cannot standardize sunlight with precision. In this respect, certainly, the ultra-violet lamp offers an advantage. For with the same apparatus, and with the distance from the lamp also the same, the time of irradiation practically determines the dosage. This dosage is now being worked out, although, of course, we must remember that some persons are much more susceptible than others to the radiation, just as individuals differ in their tolerance of our common drugs.

IRRADIATED FOODS

The substance in the skin which responds to the ultra-violet is associated with cholesterol, and a similar substance is found in certain plants associated with phytosterol, which suggested that probably the vitamine could be produced in certain foods by irradiation, thus making unnecessary the ingestion of the unpalatable cod liver oil. Irradiated grain foods, irradiated milk and similar products have given promise of usefulness. Such irradiated foods are now on the market, as are also concentrated products obtained by treating an impure ergosterol with ultra-violet rays. The dose of the latter product is extremely small, and an overdose is harmful. It is said to represent 100,000 times its weight of cod liver oil as far as the antirachitic effect is concerned. Strange to say, however, when ergosterol, or a food containing it, is irradiated too long, the vitamine becomes inactive. Indeed, the whole study of irradiated foods, and of cod liver oil substitutes generally, is still in its infancy, and much remains to be learned, if not in regard to the technique of their preparation, then certainly as regards proper dosage. A preparation of irradiated ergosterol has been approved by the Council of Pharmacy and Chemistry of the American Medical Association,

and may be accepted as quite reliable. But such products should be considered as medicine, to be taken under medical supervision.

USE OF LAMPS

The same cautious course should be followed also in the employment of ultra-violet radiation when this is produced artificially. We know that sunlight does not ordinarily harm us if we avoid sunburn. But the radiation from arc lights or mercury vapor lamps embodies the wave-lengths shorter than those found in sunlight which comes to us filtered by the atmosphere. It is also more intense. For these reasons the radiation artificially produced is far more dangerous. But unquestionably, the contrivances to furnish ultra-violet and thus to compensate for our loss of normal sunshine, are, if used properly, of great value. It is not wise, however, to proceed to self-treatment without expert direction. Here also conservatism is the part of wisdom. Let those who have been specially trained, do the pioneering.

THE ZONES OF ULTRA-VIOLET RAYS

The radiation from an arc or vapor lamp produces violet, blue, green and yellow light waves, which can be filtered out; and also ultra-violet rays from the violet down to a wave-length of about 1850 to 1870 Å. Waves shorter than 1850 Å are cut out by quartz and are never found in the radiation from a mercury vapor lamp. The waves of the Dorno region, 2900 to 3130 Å, and the longer ones, have the action of sunlight, but are of course supplied in greater abundance. Like sunlight they stimulate metabolism, govern our calcium balance, increase the alkalinity and the iron content of the blood, sharpen the appetite, and may be used in the treatment of rickets, certain skin diseases, and of tuberculosis. Such skin irradiation produces a slight rise in the temperature, which soon falls to normal. It does not affect the blood pressure. If prolonged, it can, of course, cause sunburn, and it may cause inflammation of the eyes, this being due mainly to the waves shorter than about 3050 Å.

Waves shorter than 3000 Å are correspondingly more irritating and more dangerous to the eyes. Since these shorter waves are produced in the operation of electric welding, they are frequently encountered, and their dangerous nature should be kept in mind. Goggles of special glass, designed to intercept them, are worn by the persons engaged in such operations; the spectators, however, are not so protected, and must look out for themselves.

BACTERICIDAL RAYS

The waves shorter than 3000 Å and longer than 2000 Å are decidedly bactericidal, particularly those between 2490 Å to 2380 Å. But longer wave-lengths also have a killing effect on some germs, though in a much lesser degree. Indeed, this is true in a measure in regard to the violet, the blue, and the green of the visible spectrum. Speaking generally, the longer the wave-lengths, above 3000 Å, the less effective are the rays in the destruction of bacteria.

OZONE

Waves shorter than 3000 Å also convert oxygen into ozone, hence this substance is always in evidence when an ultra-violet lamp is in operation. Ozone is a very active oxidizing agent, and in dilution acts on us as a stimulant. It is interesting in this connection to note that the solar radiation forms ozone in the upper regions of the atmosphere, and that when the sky is clear, and when the wind is from the west or the southwest, some of the ozone is found at the earth's surface, thus augmenting the exhilarating effect of the outdoor air, when we are out for a stroll under such weather conditions. It may explain also why we are apt to feel less energetic when the wind is from the east, for then the ozone is absent. Old-fashioned fishermen may even contend that it provides justification for their deep convictions to the effect that "When the wind is from the east, the fishing is the least." But no one gives credence to what fishermen say.

A NEW TOOL FOR THE CHEMIST

To the chemist the ultra-violet lamp has opened up new methods of identification. Since so many substances exhibit characteristic fluorescent properties, this fact may be utilized for identification and for the detection of small quantities of certain contaminations or adulterations. The ultra-violet lamp may be used in food analysis, in clinical chemistry, and in mineralogy to identify rock components. The modern Sherlock Holmes will use not only his microscope but also his ultra-violet lamp. In the examination of documents, to detect suspected alterations, to establish the authenticity—or the reverse—of old paintings, this strange radiation is of great assistance. In the paint industry it may be employed to study the resistance to sunlight of various paints and varnish mixture. Its applications for the chemist seem indeed almost endless. It is a tool of great value to the analyst as well as to the physician. But it must, of course, be handled with caution. Such a lamp is not a plaything.

ANCIENT AND MODERN SUN-WORSHIP

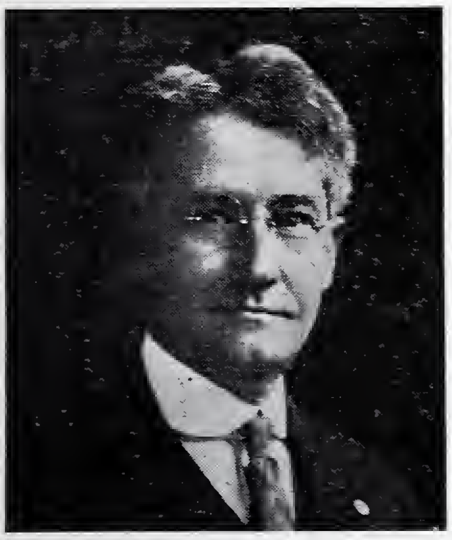
Man has since time immemorial recognized sunlight as a natural agency of paramount influence. Many primitive races worship the sun as a deity, a practice at one time quite general and extending over long periods of time. Our American Indians still conduct their sun-dances. The ancient sun-worship, not only in Africa and in Asia, but also in Europe, and on this continent, had its gruesome aspects, for it entailed, frequently, human sacrifice—sacrifice to the sun-god. The modern sun-cult, should, however, exhibit no such inhuman features. Only ignorance, leading to the reckless misuse of sun-therapy, can call for victims. Let us hope, therefore, that this new health-giving agency may be employed wisely and conservatively by the enthusiastic devotees of the modern sun-cult and that experimentation in this field may be limited to persons who have the necessary knowledge and skill.

THE ROMANCE OF BEVERAGES

By Charles H. LaWall

"Water, water everywhere
Nor any drop to drink."

AND SO WE EMBARK on a voyage concerning liquid refreshment with a quotation which is as familiar as any that could be selected, and as non-committal. Indeed, he who lectures upon a subject with such a title must be prepared in advance to lose half his audience if he devotes too long a time to either of the two great parts into which the subject may be divided, for only a small proportion of people are amphibious in this connection.



Charles H. LaWall, Ph. M. Sc. D.

Perhaps I may succeed better if I arrange my sub-topics in successive layers—a sort of verbal *pousse-café,* so to speak; but already I have transgressed in naming a drink which is under the ban of the law. I do not wish to make such a mistake as was made by the clergyman who unthinkingly selected "Oh, Happy Day" for one of the hymns to be sung at the close of a stirring sermon on prohibition. Hum it over to yourself and see whether it suits the occasion. Neither shall I denature the facts as the committee denatured the poem entitled *Mare Rubrum,* which was submitted by Oliver Wendell Holmes for a certain convivial occasion.

The word "beverage" comes from the same root-word as do the words "bib" and "bibulous," and the word "drink" comes from the same original source as the words "drown" and "drunken"; so from the beginning to the end of our existence we are encompassed by the vicissitudes and hazards of a craving for liquids, a craving which is sometimes physiological and sometimes pathological, but a craving which is always real.

Considering that in our physical make-up we are largely composed of water (and some of us are more highly diluted than others) we come by a desire for liquid refreshments naturally. For a normal individual, living under normal conditions, on a normal diet, water satisfies every physiological need, and yet, so few of us lead normal

lives that we are rarely satisfied with the necessities of life. We either want the water flavored, sweetened, and effervescent, or we want one of the numerous substitutes which man seems to have craved since his cradle days in the forgotten past, when *pithecanthropus erectus* accidentally allowed a vessel of fruit juice to stand a day too long, and after drinking the resulting liquid was transformed into *homo sapiens.*

I am reminded here of a German verse which once appeared as a mural decoration in a well known Philadelphia restaurant, now no longer in existence, for obvious reasons:

"Das wasser ist zu jeder zeit
Die beste aller Gottesgaben;
Doch, lehrt mich mein bescheidenheit
Mann muss nich immer besten haben."

And so we find that this modesty has led man into devious paths which we shall follow for a time in the hope of finding facts and fancies for an hour's enjoyment. We are not going to spend any time discussing the liquid that made the old oaken bucket and the cataract of Lodore famous. We admit its value and necessity.

"Traverse the desert and ye can tell
What treasures exist in the cold deep well;
Sink in despair on the red parched earth,
And then ye may reckon what water is worth."

Kipling knew a thing or two about water, for when he wrote *Gunga Din* he says:

"Ye may talk o' gin and beer, when you're quartered safe out here
And sent to penny fights and Aldershottit,
But when it comes to slaughter, you'll do your work on water
And you'll lick the bloomin' boots of him that's got it."

We shall not visit the famous spas or watering places of history, for here the subject begins to border on the therapeutic side, and with that we have nothing whatever to do. We shall confine ourselves to the things that men have drunk for the sake of drinking, or as substitutes for Adam's ale. The very work "drink" is ambiguous. If you ask a person the question "Do you drink?", he may take it either as an insult or as an invitation, but the thought of water is usually remote.

Social drinking is as old as society itself, and whether the beverage is served in public or in private, and entirely irrespective of its character, there is a psychological need which is satisfied as well as one that is physiological. The reasons for drinking have been summarized in verse form by a sixteenth century poet:

"If all be true that I do think,
There are five reasons we should drink.
Good wine, a friend, or being dry,
Or lest we should be by and by,
Or, any other reason why."

A later version equally unrestricted in its terms is this:

"There's a rule to drink
I think,
A rule of three,
That you'll agree
With me
Cannot be beaten
And tends our lives to sweeten:
Drink ere you eat
And while you eat
And after you have eaten."

Let us not, in our academic consideration, at least, exhibit the Moslem's abhorrence of alcoholic beverages. It is said in this connection that if one digs a hole in the ground and pours therein a single drop of alcohol, and if the hole is then filled up with earth, and grass planted on the spot, a true Moslem may not eat of the flesh of a sheep that grazes on that spot.

There is a wide gulf between the adherents of Old King Cole and John Barleycorn on the one hand and Little Miss Muffet and Jack and Jill on the other, and he who seeks to pursue the middle course finds himself between the upper and the nether millstones.

But let us take the plunge "with malice toward none and charity for all," and as a beginning see whether we can discuss the beverage made famous by being dedicated to Bacchus, without starting any of the revels made notorious by the same ivy crowned god of ancient Greece, who had almost as many aliases as a Chicago racketeer. Bacchus, who is supposed to have introduced the cultivation of the vine, and who is synonymous with Dionysius, is said have sprung from the thigh of Zeus and to have come to Europe from India by way of Egypt. The accompaniments of Bacchus in painting

and sculpture, were the vine, the ivy, the thyrsus, the wine cup, and the panther. One curious chronological error or inconsistency exists in the statue of Bacchus. It is that the early representations of him show him as a mature bearded man, while those of later centuries portray him as a beardless youth. Perhaps his wine had the effect of an elixir of youth, and not only preserved but rejuvenated his memory.

The ivy with which Bacchus was crowned has added significance when we learn that the berries and the leaves, when made into an infusion, were taken as an antidote to bad wine. A sprig of ivy was often hung before a wine shop, which later gave rise to the saying, "Good wine needs no bush."

The Bacchus-admiring Greeks believed that the amethyst would protect the wearer against drunkenness, and the word "amethyst" comes from Greek root words which convey this meaning. Not all persons who wear amethysts, however, use them for this purpose.

Reproduction of Ancient Frieze Showing Procession of Bacchus

BIBLICAL BEVERAGES

Before the time that Bacchus made the vine famous in the Mediterranean countries, Noah had contributed his share to the gayety of nations in Palestine. "And Noah began to be a husbandman, and he planted a vineyard." Noah had seen enough water to last him for a while, says one early commentator. Another early writer explains in detail the reason which led Noah to specialize in grapes. Noah had observed that a goat that had eaten of wild grapes became very frisky and fought with great courage. Noah planted a cutting of this particular vine and fertilized it with the blood of a lion, a lamb, a hog, and a monkey. This is supposed to account for the contradictory attributes which wine inspires in different persons, and so we have boldness, meekness, filthiness, and obscenity engendered by the fermented juice of the grape.

There will be no attempt to discuss varieties or vintages of wine, much less the many descriptive names. Still or sparkling, sweet or

dry, harsh or smooth—wine is the fermented juice of grapes particularly, and of other fruits occasionally. There were no laws among the Greeks and Romans prohibiting the adulteration of wine, and so certain practices grew up which may account for the early demise of certain rulers of classical Greece and Rome. The wine makers of early times had learned empirically that the addition of sugar of lead or of litharge made harsh wines milder and aided in their preservation. Both of these substances are slow poisons, but were not generally recognized as deleterious until very recent times, in spite of the fact that Vitruvius, a Roman engineer of the time of Julius Caesar, had described the symptoms of chronic lead poisoning with great accuracy, and even in Seventeenth century Germany we find physicians defending the use of lead compounds in preserving wines. The Greeks and Latins had also learned the art of "plastering" wines with gypsum to improve their quality, and this less harmful practice has continued in some European countries down to the present time.

Jesus' first miracle consisted in changing water into wine at the marriage feast at Cana. It will suprise many to learn that this miracle was claimed to have been repeated at least twelve times by early Christians of prominence who were later canonized for their good deeds. Among these may be mentioned St. Adelm, St. Agnes, St. Arbert, St. Gerard, St. Gerlac, St. Guido, St. Odilo, St. Vaast, St. Victor, St. Zita, Peter Celestine, and Peter the Hermit, the last of these transformations having taken place as late as the thirteenth century. Each of these miracles is described in great detail, no two of them being exactly alike.

Wine drinking was so common a custom in biblical times as to call for no particular censure except from St. Paul, and he had his reservations. It will be remembered that at the feast of Pentecost, when the disciples are said to have spoken in foreign tongues and unkind critics said "These men are full of new wine," Peter in indignation replied "These men are not drunken, as you suppose, seeing it is but the third hour of the day." The name *Lachrymae Christi* (literally, Christ's tears) was given to a variety of wine without any intended irreverence.

There have been many noted wine drinkers as well as many famous varieties of wine. Darius the First, who was nicknamed the "Huckster" because of his interest in trade, and who is chiefly

remembered for what he did to Babylon, wished the following epitaph to be placed upon his tomb:

"I could drink much wine and bear it well."

Philip the Macedonian who when in his cups snubbed a woman who had come to him for justice gave his quick witted subject an opportunity for repartee which has come ringing down the centuries, for when the woman exclaimed indignantly "Philip, I shall appeal against this judgment," and Philip thundered in kingly rage "To whom will you appeal?", the woman replied, mildly but effectively, "I shall appeal from Philip drunk to Philip sober."

The libations of the Greeks and Romans which usually consisted in pouring a small portion of the wine either on the ground or on the sacrificial victim on the altar, were paralleled by the drink offerings of the ancient Jews. The Romans had a non-alcoholic wine called *Adynamon* (literally meaning, without power) which was much used by Roman matrons as a tonic beverage.

Beginning with the sixteenth century there were many liquor loving litterateurs and laureates in England, and one of the nicknames of Ben Johnson was the "canary bird," because of his fondness for Canary wine. Ben did not always agree with the motif of his famous song "Drink to me only with thine eyes." The drinkers in those earlier days were discriminating and one of the most famous of these upon having received a present of some sherry sent as a remedy for his gout said, "I have tried your sherry and prefer the gout."

Capacity was estimated not by ordinary units of measurement such as drams or gills but by bottles, and the terms "one," "two" and "three bottle men" were in common use. One of the latter who was interrogated with surprise with the question "Have you finished all three bottles of port without assistance?" replied "Oh, no! I had the assistance of a bottle of madeira." If tradition is to be believed the Duke of Clarence who was drowned in a butt of malmsey, was one of the few English noblemen who died of drink without being drunk, for the period was one in which the expression "drunk as a lord" probably had its origin.

Sack is an unexplained mystery of Tudor times. It is believed to have been a dry, rough wine brought from the Canaries to Spain and thence to England, and was much used in punch and posset. It is mentioned frequently in the writings of Pepys, Evelyn, Shakespeare, and Beaumont and Fletcher. Posset is a drink made from

wine, milk and eggs which was popular in Shakespeare's time, for he says: "We'll have a posset at the latter end of a sea coal fire." It was made from any available kind of wine or even from cider or perry. One of the most popular varieties was a sack-posset, the recipe for which was immortalized in verse which starts off like this:

"From famed Barbadoes on the Western main
Fetch sugar, ounces four; fetch sack from Spain,
A pint; and from the Eastern Indian coast,
Nutmeg, the glory of our Northern toast."

and so on until ten eggs and a quart of milk have been added, and the whole brought to the boiling point. One of the favorite possets was called the Pope's posset.

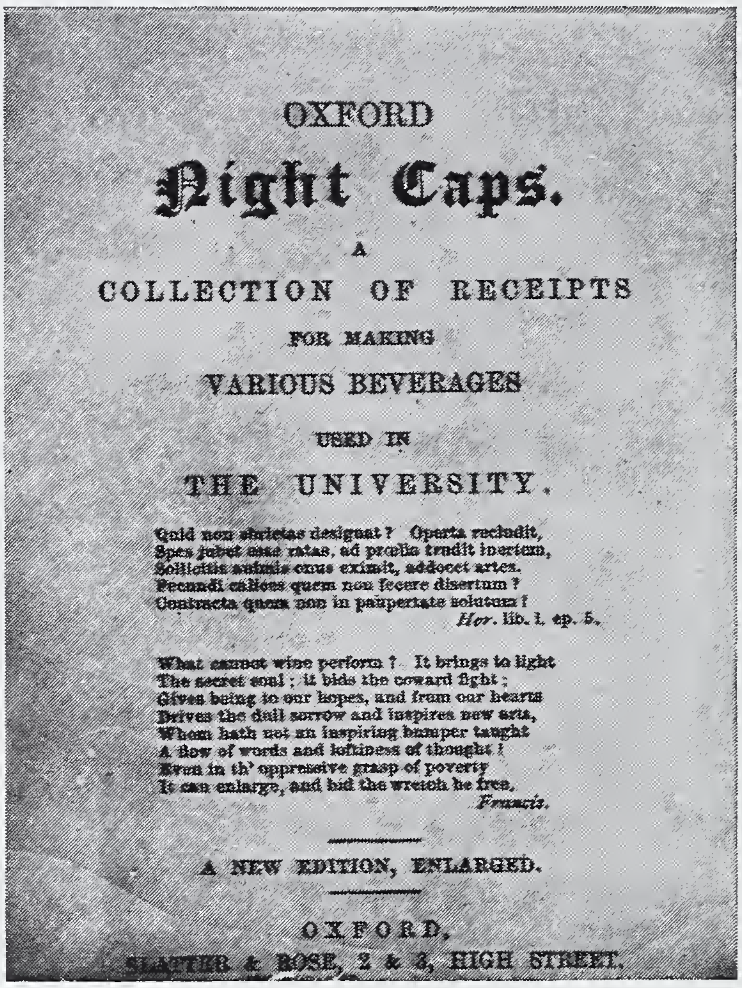
In the time of the Tudors and earlier it was customary, at coronation feasts or banquets, to dilute the wines and to cover their harshness by mixing them with honey or spices. When thus compounded by the apothecaries, who were in the technical Latin of the time called *pigmentarii,* these preparations, which were much like our modern liqueurs, were called "pigments" and are frequently referred to by Chaucer and other early English writers. One of these was called "Hippocras" because it was strained through an apothecaries' filter of peculiar form called "Hippocrates sleeve." These mixed wine drinks were very popular in England; in fact, they had not only custom but authority to sanction their use.

OXFORD NIGHT CAPS

An interesting confirmation of this is found in a little handbook which is still published, called *"Oxford Night Caps*—A Collection of Receipts for Making Various Beverages used in the University." Published in Oxford, England. In this *Vade Mecum* will be found detailed recipes for more than fifty such compounded drinks. The names themselves are intriguing. The ecclesiastical requirements are satisfied by "Bishop," "Cardinal," and "Pope." "Negus" and "cobbler" are in close rivalry with "julep," while nearly a score of varieties of "punch" take up the greater part of the book. "Possets" and "cups" are close to the punches in point of numbers, while scattered through the list are interesting titles such as "Rumfustian," "Swig," "Lambswool," "Metheglin," "Rum Booze," "Beer Flip," and others. This little work is more than a receipt book; it is a mine of information both historical and etymological, and is adorned with quotations from the

poets and classic writers. The title page contains a Latin quotation from Horace, and the following:

> "What cannot wine perform? It brings to light
> The secret soul; it bids the coward fight;
> Gives being to our hopes, and from our hearts
> Drives the dull sorrow and inspires new arts,
> Whom hath not an inspiring bumper taught
> A flow of words and loftiness of thought!
> Even in the oppressive grasp of poverty
> It can enlarge, and bid the wretch be free."


OXFORD

Night Caps.

A

COLLECTION OF RECEIPTS

FOR MAKING

VARIOUS BEVERAGES

USED IN

THE UNIVERSITY.

Quid non ebrietas designat? Operta recludit,
Spes jubet esse ratas, ad prœlia trudit inertem,
Sollicitis animis onus eximit, addocet artes.
Fecundi calices quem non fecere disertum?
Contracta quem non in paupertate solutum!
Hor. lib. i. ep. 5.

What cannot wine perform? It brings to light
The secret soul; it bids the coward fight;
Gives being to our hopes, and from our hearts
Drives the dull sorrow and inspires new arts,
Whom hath not an inspiring bumper taught
A flow of words and loftiness of thought!
Even in th' oppressive grasp of poverty
It can enlarge, and bid the wretch be free.
Francis.

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Title-Page of "Oxford Night Caps"

In this Oxford book we learn that Negus is the family name of the originator of this drink; that julep is a sweet drink of Persian origin which Milton extols:

> "Behold this cordial julep here,
> That flames and dances in his crystal bounds
> With spirits of balm and fragrant syrups mixt."

Also that punch comes from the Sanskrit *pancha,* meaning five, because a properly made punch contains five ingredients—spirit, acid, spice, sugar and water. We are informed that cider cup and perry

cup (perry being the name for pear cider) owe their virtues to the sprigs of fresh herbs, balm and borage, placed therein; balm, because it is "very good to help digestion," and borage, because it is "of known virtue to revive the hypochondriac and cheer the hard student."

The "wassail" or "swig," as it is called at Jesus College, is a combination of sherry, beer, nutmeg, ginger, sugar, lemon, and toasted bread. Our custom of drinking what we call "toasts" originated at a time when toast was an ingredient of many drinks. The word wassail comes from the ancient Saxon *wass-hael,* and is given in German as *wacht heil.* It is really a salutation equivalent to saying "Your good health."

"Then lift the can to bearded lip
And smite each sounding shield
Wassail! to every dark ribbed ship,
To every battle field."

"Lambswool" is a corruption of *La mas ubal*—the day of the apple fruit—and is made from apples, ale, sugar, nutmeg, and ginger. It was the favorite drink of the Hibernians before they invented *uisge beatha,* literally, water of life, which we have changed into the name "whisky," and which is also called "poteen." "Metheglin" or "mead" is probably derived from the Welsh "Mevdyglyn," a popular drink of the early Cymrics. It is made by fermenting a mixture of honey, spices, and water.

"The juice of bees, not Bacchus, here behold,
Which British bards were wont to quaff of old;
The berries of the grape with Furies swell,
But in the honeycomb the Graces dwell."

Perhaps it was metheglin which had been drunk the night before by William of Normandy who, after the battle of Hastings, said: "I care not who makes these barbarians' wines; send me the man who can remove the beehive from my overwrought brain."

The maximum price fixed by law during the sixteenth century for the sale of wine was twelve pence per gallon. But "why bring that up?"

We shall close this section with another German quotation, the sentiment of which still has supporters:

"Wer liebt nicht wein, weib und gesang,
Der bleibt ein narr sein leben lang."

THE STORY OF TEA

And now, for fear we may have had too much exhilaration in connection with the discussion of wine, let us turn our attention to the milder beverage tea, for a short time. Here we have a startling statement to make, to begin with. *The birth of the United States as a nation was due to a threepenny tax on tea.* Not but that there were other factors of importance, but during that critical period preceding the Declaration of Independence, when laws oppressing the colonists had been passed and then either repealed or not enforced, the tax on tea was pressed to

The Tea Plant in Blossom

the point where public patience became exhausted. Indeed, Lord North had declared his willingness to repeal all other taxes, but he promised *Georgius Tertius* that "he would maintain this one tax on tea to prove to the colonists his right to tax them."

There is no need to recount the incident of the Boston Tea Party nor to describe the public meeings that were held in other prominent cities, but the fact seems to be plainly established that this one feature of the oppression seemed to change the previous lethargy of the colonists into concerted action toward the maintenance of their inherent rights as they saw them.

The interesting part of the story of tea, probably the world's most popular beverage, is that its early history is involved in almost impenetrable obscurity. We can understand the perfectly logical manner in which a substance like wine, which is a fruit juice that has undergone certain natural changes which may be entirely spontaneous, might be accidentally discovered and frequently is re-discovered, even in our own time, but when it comes to the selection of this particular shrub, the leaf of which requires some kind of careful preliminary manipulation, and from which the beverage is subsequently prepared by infusion with boiling water, the whole procedure is more or less complicated and accidental discovery seems almost out of the question. Hence it is that there are various fanciful legends that are supposed to account for the origin of the use of tea, none of which are convincing.

The most plausible reason is that in a country where the water is unsafe for drinking purposes unless it has been boiled, there would be more or less empiric experimentation in the hope of finding something that would make boiled water more palatable. Some warrant is given for this view by a statement regarding tea which is attributed to Chin-Nung, a celebrated scholar and philosopher who antedated Confucius. He said: "Tea is better than wine for it leadeth not to intoxication, neither does it cause a man to say foolish things and repent thereof in his sober moments. It is better than water for it does not carry disease; neither does it act as a poison, as does water when the wells contain foul and rotten matter." This is very significant as showing the Chinese to have suffered from water pollution from the earliest times, and it is remotely possible that in the attempt to cover the flat, insipid taste of boiled water the virtues of this particular shrub should have been discovered.

One of the earliest detailed references to the manner of preparing tea is found in a manuscript of Kieulung in the fourth century, as follows: "On a slow fire set a tripod whose color and texture show its long use, and fill it with clear snow water. Boil it as long as would be sufficient to turn crayfish red, and throw it upon the delicate leaves of choice tea. Let it remain as long as the vapor arises in a cloud and only a thin mist floats on the surface. Then at your ease drink the precious liquor so prepared, which will chase away the five causes of sorrow. You can taste and feel but not describe the state of repose produced by a beverage thus prepared."

In the seventh century a learned Chinese named Lo-Yu was as enthusiastic in its praises as some of its later supporters who considered it more of a medicine that a beverage. He said: "It tempers the spirits, harmonizes the mind, dispels lassitude and relieves fatigue, awakens thought and clears the perceptive faculties."

And now comes a very interesting part of the story of tea. There is no word for tea in the Sanskrit language, nor does it appear to have been known to the Egyptians, Babylonians, Greeks, or Romans. It seems not to have reached Japan until the ninth century. It was brought to Europe by Arabian merchants in the eighth or ninth century, and Moorish travelers soon encouraged its widespread introduction into the Mediterranean countries in the tenth century. It took another five hundred years for it to reach Northern Europe, but whether the credit is due to the Portuguese or to the Dutch, both of whom traded in the Orient, is difficult to determine.

The first individual to advocate the use of tea in Northern Europe was Cornelius Bottrekoe, a professor in the University of Leyden, who published a treatise on "Tea, Coffee and Chocolate" in 1649. In 1658 an English writer called attention to "that excellent and by all physitians approved, China drink called by the Chineans Tcha, by other nations Tay, sold at the Sultaness Head, a Cophee House by the Royal Exchange, London." By the year 1660, only two years later, its virtues were extolled like a patent medicine of the Victorian period:

"Making the body active and lusty, helping the headache, giddiness and heaviness, removing the difficulty of breathing, clearing the sight, banishing lassitude, strengthening the stomach, causing good appetite and digestion, vanishing heavy dreams, easing the frame, strengthening the memory, and finally preventing consumption, particularly when drank with milk."

What more could one desire?

In this same year of 1660 an excise tax of eightpence was imposed on every gallon of tea made and sold, to be paid by the maker thereof. Later this was supplemented by a tax of five shillings a pound on the leaf, which was complained of as "no small prejudice to the article as well as inconvenience to the drinker."

Of course, Pepys tried tea and recorded his impressions. That goes without saying for that famous diarist did not miss much that was going on in the London of his day. On September 25, 1661, he relates: "I did send for a cup of tea, a China drink, of which I

never drank before." A few years later in 1667 he says: "Home, and there find my wife making of Tea, a drink which Mr. Pelling, the Potticary, says is good for her cold."

To show the esteem in which tea was beginning to be held in England at about this time it is recorded in 1664 that the East India Company deemed a package of two pounds of tea a worthy present for the King. There were those, of course, who tried to stem the rising tide of the popularity of this beverage which had already made quite a record for variant forms of spelling of a three-letter word, for in addition to the forms already mentioned we find it spelled "the" and "tey," and there are probably others also.

One prominent Englishman, Saville, reproved in emphatic language "those who call for tea instead of wine," and stigmatized it as "a base unworthy practice" and lamented that "all nations are getting so wicked as to have these filthy customs." What was the effect of the opposition? Let us refer to the importation figures for two periods, not very widely separated in years. From 1668 to 1674 the total importations of tea of the East India Company into England amounted to less than 500 pounds. In 1720, within less than half a century, the importations amounted to some thousands of pounds annually. Tea had arrived, and it is still with us, and will be even if the Anti-Saloon League puts it on the black list.

Tea played an important part in the development of the American Merchant Marine. Clipper ships were built expressly for the tea trade and during the first half of the nineteenth century the seven seas were dotted with the sails of these incomparable examples of the art of ship building. Tea has won its place as a world's necessity. Progressing from the east to the west it has spread from castle to cottage, and its devotees (as they may be properly called) are now numbered by the billions.

Sairy Gamp drank tea—sometimes. Her preference, however, was for something with more authority and she wanted it when she wanted it. "Don't ask me whether I won't take none or whether I will, but leave the bottle on the chimney piece and let me put my lips to it when I am so dispoged." But she was jealous of her rights, too, for to her friend Betsy Prig, she says "No, Betsy! Drank fair, wotever you do."

We could spend the remaining time allotted to this lecture in telling interesting and surprising things about tea. Do you know that black tea and green tea are not different varieties, but are simply

the result of different methods of preparing and curing the same leaves? Would it surprise you to learn that Orange Pekoe is merely a distinctive name for the leaves that comprise the tender buds at the ends of the shoots or branchlets, and that a single tea plant will furnish a number of grades and kinds of tea which are given different trade names as Congou, Bohea, Young Hyson, and others? These are facts available in any modern reference book, so we shall leave tea and pass to another beverage for a change. But wait—let me call your attention to the fact that I have been talking about tea for ten minutes and have not once referred to it as "the cup that cheers." There is one rarely quoted reference to tea that I would like to leave with you as a final thought: "Tea! Thou soft, thou sober sage, and venerable liquid; thou female tongue-running, smile-soothing, heart-opening, wink-tippling cordial, to whose glorious insipidity I owe the happest moments of my life, let me fall prostrate."

COFFEE AND COFFEE HOUSES

What shall our next venture be? We might as well take up the strongest rival of tea as a table beverage. Whether we spell it coffee, cophee, coava, cobo, café, cauphe, coffa, or any other of the more or less Chaucerian forms in which we meet the word in the early literature, there are millions of individuals, especially in America, who cannot start the day without a cup of this famous decoction, whose early history is involved in almost as much obscurity as that of tea.

We learned a little while ago that tea was responsible for the Declaration of Independence. What responsibility can we fix upon coffee? Well, perhaps nothing quite so spectacular as American Independence, but we cannot mention marine insurance without thinking of the name Lloyds, which was a famous coffee house in the seventeenth century in London, where ship owners and financiers met to arrange for insurance on ships and their cargoes, and both the *Tatler* and the *Spectator,* which marked the advent of modern journalism, had their inspiration in these same coffee houses of eighteenth century London, for when Richard Steele instituted the *Tatler* in 1709 he said in the opening number:

"All accounts of gallantry, pleasure and entertainment shall be under the article of White's Coffee House; poetry under that of Will's Coffee House; learning under the title of Grecian; foreign and domestic news you will have from St. James' Coffee House, and what else I shall on any other subject offer shall be dated from my own apartment."

But we are getting ahead of our story. No reference to the coffee berry or its beverage is found in the records of the Pharaohs, nor did the Mesopotamians mention it, nor their Hebrew contemporaries. The Greeks and the Romans were as ignorant of coffee as they were of tea, in fact, the first authentic references to coffee come through the Arabians from a period some time after the Crusades. Coffee came to us originally from the Ethiopians, who are said to have used it from time immemorial. The Abyssinians, that mysterious, dark-skinned Semitic race, were the first civilized people to learn its use, and it was from them that the Arabians obtained knowledge of it somewhere about the twelfth century. The oldest written reference to it is in an Arabian manuscript now in the *Bibliotheque Nationale* of Paris, which dates from the thirteenth century.

The Coffee Plant in Flower and Fruit

Coffee became extensively used in Aden by the fifteenth century "first among lawyers and professional men, then with students and those who learned reading, the custom eventually spreading to artisans and others who worked in the night, and finally by travelers

who journeyed in the night to avoid the heat of the day." It was then held by its users that "This liquor purified the blood by a gentle agitation, dissipated the ill condition of the stomach and aroused the spirits."

It was used by the Mohammedans as a devotional anti-soporific in connection with their prolonged religious services. It soon became a subject for controversy. Coffee was held by the orthodox Mohammedans to be an intoxicating beverage and therefore prohibited by the Koran (please don't tell Mr. Volstead about this), but notwithstanding the threats of divine retribution held out by the ultra-orthodox, the coffee drinking habit spread so rapidly among the Arabians that this beverage is as inseparably connected with Arabia as tea is with China. Its use spread from Aden to Mecca and Medina, thence to Syria and Persia and later to Turkey. Public coffee houses were everywhere established in the near East, affording "a lounge for the idle and a relaxation for the man of business where the politician retailed the news of the State, the poet recited his verses and the Mollahs delivered their sermons to the frequenters."

The Syrian authorities attempted to check and finally to suppress these coffee houses on the alleged ground of "its intoxicating properties," but in reality because these social and political gatherings were incompatible with the strictness and teaching of Mohammedan religion. In Cairo and other eastern cities also there were alternations of edicts forbidding its use and their prompt rescinding when their ineffectiveness was realized.

In Constantinople coffee soon became the favorite drink of all classes, "the coffee houses being thronged night and day, the poorer classes actually begging money in the streets for the sole object of purchasing coffee," and "a refusal to supply a wife with a specific quantity of coffee per diem was admitted to be a valid cause for divorce." Again the ecclesiastical authorities rose in opposition and used their influence wth the Sultan to curb this evil. The Sultan, profiting by the experience in other communities where edicts of suppression had to be rescinded, simply laid a heavy tax on coffee houses, notwithstanding which they continued to flourish and to spread.

The dervishes then played a trump card by claiming that "coffee when roasted became a kind of coal, and that coal was one of the substances which Mahomet had declared was not intended by Allah for human food," and the coffee houses were immediately closed. This prohibition was found absolutely impossible to maintain, and

after a few years pressure enough was brought to bear to change the ruling and the faithful were assured that "roasted coffee was not coal and bore no relation to it." This was in the sixteenth century but many people still believe that the passage of a law or the issuance of an edict would have the effect of changing human nature and human desires.

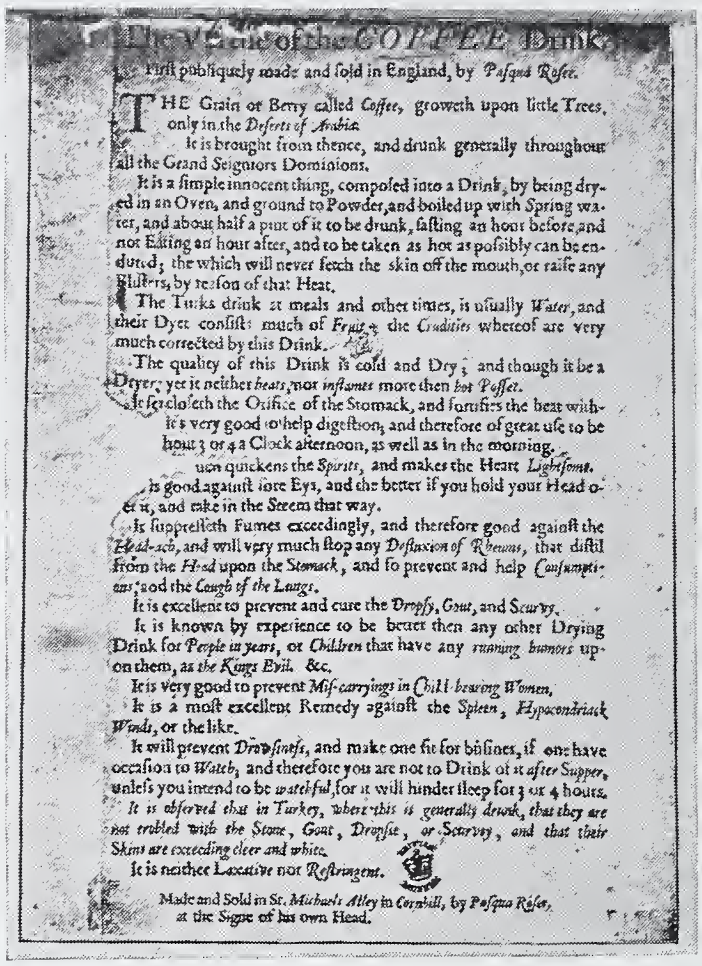
The introduction of coffee into the northern countries of Europe did not take place until the latter part of the seventeenth century, when we find it first referred to by travelers and writers and some of these later actually brought along for trial a few pounds of the precious berries which at first sold for a price equivalent to about twenty dollars a pound. Burton in his *Anatomy of Melancholy* had referred to a "Turkish drink called coffee" in the year 1621, and Bacon in the same year in his *Sylva Sylvarum* referred to coffee as "the drink that comforteth the brain and head and helpeth digestion," but it is not probable that either Burton or Bacon ever tasted coffee.

Pepys does not seem to have paid much attention to coffee. Perhaps his "potticary" did not recommend it for Mrs. Pepys as he did tea, and anyway, Pepys himself was more fond of "sack" than of milder beverages. His rival diarist, Evelyn, however, records the following in his memoirs:

"There came in my time to the college (Oxford) one Nathaniel Canopios out of Greece in the year 1637. He was the first I ever saw drink coffee, which custom came not into England till thirty years after."

The first coffee house in England was not in London, but in Oxford, and was established in 1650 by a Jew named Jacob. Two years later a Greek named Pasque Rossee opened the first coffee house in London in St. Nicholas Alley, Cornhill. Rossee's first advertisement is still in the British Museum and is a simple statement of fact without any special claims for the virtues of the beverage. By 1657 several other coffee houses had been established, and as was true of other places, opposition arose, but the first opposition in England was not from the Church nor from the State. It was from the vintners and brewers who charged them with being "nuisances and a prejudice to the neighborhood." Public opinion, however, as in Arabia and the Near East, welcomed them, and coffee houses spread with great rapidity throughout both England and France. In the latter country they were called cafés, but many a modern café serves other things that are superior to its coffee.

In England coffee was taxed in the liquid state, just as tea was a few years later. Fourpence a gallon was the rate and a penalty of five pounds a month was inflicted upon coffee "speakeasies," when they were detected and apprehended. Even the coffee used for domestic consumption at that time was purchased in beverage form from the coffee houses. The first known newspaper advertisement of coffee in England is found in 1657 and is worth quoting as an example of the wonderful medicinal powers the beverage was credited with possessing.



The Vertue of the COFFEE Drink.

First publiquely made and sold in England, by *Pasqua Rosee.*

THE Grain or Berry called *Coffee*, groweth upon little Trees, only in the *Deserts of Arabia.*

It is brought from thence, and drunk generally throughout all the Grand Seignors Dominions.

It is a simple innocent thing, composed into a Drink, by being dryed in an Oven, and ground to Powder, and boiled up with Spring water, and about half a pint of it to be drunk, fasting an hour before, and not Eating an hour after, and to be taken as hot as possibly can be endured; the which will never fetch the skin off the mouth, or raise any Blisters, by reason of that Heat.

The Turks drink at meals and other times, is usually *Water*, and their Dyet consists much of *Fruit*, the *Crudities* whereof are very much corrected by this Drink.

The quality of this Drink is cold and Dry; and though it be a Dryer, yet it neither *heats*, nor *inflames* more then *hot Posset.*

It forecloseth the Orifice of the Stomack, and fortifies the heat with-

it's very good to help digestion, and therefore of great use to be

bout 3 or 4 a Clock afternoon, as well as in the morning.

uch quickens the *Spirits*, and makes the Heart *Lightsome.*

is good against sore Eys, and the better if you hold your Head over it, and take in the Steem that way.

It suppresseth Fumes exceedingly, and therefore good against the *Head-ach*, and will very much stop any *Defluxion of Rheums*, that distil from the *Head* upon the *Stomack*, and so prevent and help *Consumptions*; and the *Cough of the Lungs.*

It is excellent to prevent and cure the *Dropsy*, *Gout*, and *Scurvy.*

It is known by experience to be better then any other Drying Drink for *People in years*, or *Children* that have any *running humors* upon them, as *the Kings Evil.* &c.

It is very good to prevent *Mis-carryings in Child-bearing Women.*

It is a most excellent Remedy against the *Spleen*, *Hypocondriack Winds*, or the like.

It will prevent *Drowsiness*, and make one fit for busines, if one have occasion to *Watch*; and therefore you are not to Drink of it *after Supper*, unless you intend to be *watchful*, for it will hinder sleep for 3 or 4 hours.

It is observed that in Turkey, where this is generally drunk, that they are not trobled with the Stone, Gout, Dropsie, or Scurvey, and that their Skins are exceeding cleer and white.

It is neither *Laxative* nor *Restringent.*

Made and Sold in St. *Michaels Alley* in *Cornhill*, by *Pasqua Rosee*, at the Signe of his own Head.

First English Advertisement of Coffee, 1652

"In Bartholomew Lane, on the back side of the Old Exchange, the drink called coffee, which is a very wholesome and physical drink, having many excellent virtues, closes the orifice of the stomach, fortifies the heart within, helpeth digestion, quickeneth the spirits, maketh the heart lightsome, is good against eyesores, coughs or colds, consumption, headache, dropsie, gout, scurvy, King's evil, and many others, is to be sold in the morning and at three of the clock in the afternoons."

Anybody who advertised coffee with such claims today would be arrested for violation of the Food and Drugs Act. It was Charles II, however, who made himself the biggest fool of the century by

not heeding the experience of those who had tried to suppress coffee in other parts of the world. Coffee houses had increased in numbers and those who patronized them were prone to exchange views on political matters. In 1672 the King "having been informed of the inconveniences arising from the great number of persons that resort to coffee houses, desired the lord keepers and the judges to give their opinions in writing, how far he might lawfully proceed against them." The report was rendered that "Retailing coffee *might* be an innocent trade, but as it is used at present, in the nature of a common assembly to discourse of matters of state, news and great persons, as they are nurseries of idleness and pragmaticalness, they *might* be thought common nuisances."

PROHIBITION AND COFFEE

The question was seriously debated for three years by the King and his lords and in 1675, on the 23d of December, King Charles II issued a "Proclamation for the Suppression of Coffee Houses." This is worth repeating in full:

"Charles R.

"Whereas it is most apparent that the multitude of coffee houses of late years set up and kept within this Kingdom, the Dominion of Wales and the town of Berwick-upon-Tweed, and the great resort of idle and disaffected persons to them have produced very evil and dangerous effects, as well for that many tradesmen and others do herein mis-spend much of their time which might and probably would be employed in and about their lawful calling and affairs, but also for that in such houses divers, false, malicious and scandalous reports are devised and spread abroad to the defamation of His Majestie's Government and to the disturbance of the peace and quiet of the realm, His Majesty hath thought fit and necessary that the said coffee houses be (for the future) put down and suppressed and doth strictly charge and command all manner of persons, that they or any of them do not presume from and after the tenth day of January next ensuing, to keep any public coffee house, or to utter or sell by retail, in his, or her, or their houses or houses (to be spent or consumed within the same) and any coffee, chocolate, sherbett or tea as they will answer the contrary at their utmost peril.

"Given under our court at Whitehall this third and twentieth day of December, 1675, in the seven and twentieth year of our reign.

"God save the King."

Just think, after reigning as monarch of England for twenty-seven years Charles II knew so little about his job and his people that he thought he could get away with an edict like that. Well he couldn't and he didn't. Before January 10th arrived the clamor was so great and the protests so numerous that an extension of time was given in the following amendment:

"Out of princely consideration and royal compassion all and every of the retailers of the liquor aforesaid shall be allowed to keep open till the four and twentieth day of June next."

And this extension of time was simply for the purpose of saving the King's face, for no enforcement was ever attempted and the subject never came up again. This is a fine kind of a "blue law" to have lying around on the statute books unrepealed, isn't it?

As has been previously mentioned Steele gave credit to the coffee houses of the early eighteenth century for the material to be used in the *Tatler,* and later when Joseph Addison started the *Spectator* as the *Tatler's* successor, he too announced his intention of frequenting the coffee houses for news. Pope was familiar with coffee houses and is the author of that oft repeated quotation

> "Coffee! Which makes the politician wise,
> And see through all things with half closed eyes."

LLOYD'S AND COFFEE

The great Lloyd's Insurance Company had its origin, as has been stated, in a seventeenth century coffee house. Mr. Edward Lloyd had some time prior to 1688 established a coffee house in Tower Street, which in 1692 he removed to Lombard Street, London, which was the resort of all who were directly connected with shipping. Indeed, a weekly paper was issued in 1696 which was called *Lloyd's News,* and which was devoted to shipping intelligence. Later, *Lloyd's News* was replaced by *Lloyd's Post* and in 1774 the coffee house ceased to be a proprietary establishment and moved to the Royal Exchange under the name "New Lloyd's Coffee House," and became a co-operative organization resembling a club, with subscribing members and a general manager.

In France, the cafés as the coffee houses were called, became the mecca for people of fashion, artists, litterateurs and statesmen. Tea and chocolate were also served in these establishments, which remained on a higher plane as regards patronage than was the case in England. There was some mild opposition, but nothing official. Madame Se-

vigne placed herself upon record as saying that "coffee and other poisons would soon go out of fashion."

There had been some opposition in Italy in the sixteenth century on the part of certain fanatical priests who denounced coffee as an invention of Satan. They claimed that the evil one having forbidden his followers, the infidel Moslems, the use of wine, no doubt because it was sanctified by Christ and used in the Holy Communion, had given them as a substitute this hellish black brew of his which they called coffee. For Christians to drink it was to risk falling into a trap set by Satan for their souls. It is further related that the Pope, made curious, desired to inspect this devil's drink and had some brought to him. The aroma of it was so pleasant and inviting that the Pope was tempted to try a cupful. After drinking it, he exclaimed, "Why, this Satan's drink is so delicious that it would be a pity to let the infidels have exclusive use of it. We shall fool Satan by baptizing it and making it a truly Christian beverage."

If we credit this story, which is taken from a work called *All About Coffee* by Ukers, we have in coffee the only beverage which is a member of the Church.

In Ardennes, it is said, custom decrees the serving of ten separate cups of coffee after a formal dinner, and each one of these is given a specal name. The guests at such a banquet must feel like adopting the famous motto of the Pinkerton Detective Agency—"We never sleep."

CORTEZ AND COCOA

We might as well complete the triple alliance while we are about it, the third member being chocolate, for in most of the coffee houses of England and France, chocolate was usually served as well as coffee and tea. We know more about the introduction of chocolate to the civilized world than we have been able to learn concerning tea and coffee for the past history of chocolate is linked with the name of one of Spain's most cruel conquerors—the famous Cortez. Chocolate was originally a Mexican product and was first brought to Europe by Cortez in 1528 with a number of other interesting and novel products of the new world.

Chocolate is the paste produced by grinding the seeds of a large gourd-like fruit which grows on a tree. The seeds are improperly called beans, and are entirely devoid of the characteristic chocolate flavor until after they are roasted. The tree had undoubtedly been

under cultivation in Mexico for many centuries and the seeds, or nibs, as they are also sometimes called, were not only accepted as revenue or tribute in Mexico, but were also used in lieu of currency. One of the early Christian fathers commented upon this fact very pointedly for he referred to it as "blessed money, which exempts its possessors from avarice, since it cannot long be hoarded or hidden underground."

Cortez found chocolate the national drink of Mexico, used by rich and poor alike, particularly because of its nutritive qualities. Montezuma, the Emperor, had his chocolate prepared in the form of a thick froth, delicately flavored with vanilla and spices and sweetened with sugar or honey. The Emperor's chocolate was prepared in golden utensils and served in golden goblets and with golden or carved tortoiseshell spoons. The poorer subjects contented themselves with a less expensive beverage prepared with water and without spices or sugar.

It was the sole beverage of royalty in Mexico and no less than two thousand pitchers of the drink were prepared for the royal household, the King himself consuming fifty per day. The tree and its fruit were held in such high esteem that there were special ceremonies attendant upon the planting of the seed, and these were accompanied by a sacrifice of blood, that of a dog usually sufficing.

The Spaniards kept secret the source and method of preparing chocolate for nearly a century, during which time they encouraged its widespread use and profited by the monopoly. So well was this secret kept that during the war between Spain and Holland, although the Dutch frequently captured Spanish vessels containing shipments of raw cocoa beans, they did not recognize their identity or know their use and threw them overboard as of no value. This was probably due to the fact previously mentioned that the raw nibs are entirely without the characteristic flavor which is developed by the roasting process to which they are subjected before being ground.

In 1606 an Italian named Carletti discovered the secret and introduced the method of roasting and preparing chocolate first into his own country and later into France during the reign of Louis XIII. In a few years the use of chocolate had spread throughout Europe. There was no organized or unorganized opposition to the use of it as there had been in the cases of tea and coffee. The only criticism

on record seems to have come from a writer named Franciscus Rausch, who in 1624 published a book upon the subject in Vienna in which he urged the abolition of its use by monks, in whom it was alleged to provoke improper thoughts and desires. This belief seems to have been rather widespread and to have lasted for nearly a century, for in 1712 Addison says in the *Spectator*: "I shall advise my fair readers to be in a particular manner careful how they meddle with romances, chocolate, novels, and the like inflamers, which I look upon as very dangerous to be made use of during this great carnival."

Old Illustration Showing the Drinking of Coffee, Tea and Chocolate

In 1659 in France the manufacture and sale of chocolate was given as a monopoly to David Challon for a long period of years, but in 1693 the monopoly was abridged and all confectioners and grocers (who then included the apothecaries) were permitted to sell it.

The Mexican word for chocolate is *chocolatl*. The plant was called cacao by the Spaniards, and cacao it would have remained to this day as a popular term had it not been for the error of one of the transcribers who aided Dr. Johnson with his first English diction-

ary, and the word appeared as cocoa. This has caused endless confusion ever since, for the word cocoa is often wrongly associated with the coconut, which furnishes another edible product and also a fixed oil, and these are both confused with coca, a South American drug which yields the habit forming alkaloid cocaine.

Linnaeus, the great Swedish botanist, gave the plant its Latin name of *Theobroma,* which literally means "the food of the gods." Perhaps Linnaeus had heard the Mexican legend of the origin of chocolate, which was said to be the fruit of a tree enjoyed by the gods in an Eden-like sanctuary in Mexican tradition and given as a gift to mankind by Quetzelcoatl, one of the famous Mexican deities, who had also taught mankind many useful arts and who was reverenced highly by the natives.

We do not often employ the real chocolate as a beverage today. We substitute for it what we erroneously call "cocoa," which is made by expressing chocolate to separate a portion of the fat. This fat is called cocoa butter and is used in medicine. The residue, after expressing the fat, is called "cocoa" and has practically all the flavor of the chocolate, but is more easily tolerated by the stomach of the average user than the richer beverage produced from chocolate itself. Chocolate and cocoa more frequently appear in foods and confections than in beverage form, although the latter use is rapidly increasing.

THE UNIVERSALITY OF STIMULANTS

Before leaving the interesting triumvirate of non-intoxicating beverages let us give a little philosophical consideration to the very obvious fact that man seems to need a stimulant. Tea and coffee contain caffeine, chocolate contains theobromine, both of which principles are stimulating, and the three plants yielding these beverages are entirely unrelated botanically, and originated in parts of the world each entirely remote from the other and were discovered by peoples who were in very primitive states of civilization. To add still further to this interesting field of speculation, there are three additional beverage-producing substances, all containing caffeine, which have been used by the aborigines of three different continents for their stimulating qualities. These are kola of Africa, maté or Paraguay tea of South America, and Cassina of our own southern United States in North America. This is more than a coincidence and is worthy of especial research in itself, as proof of the fact that even aboriginal man always craves stimulation

and invariably finds the right product to produce the desired effect. This basic fact may have an important bearing upon sociological and political questions. The influence of these various stimulants upon particular eras of intellectual and social development would be an interesting field of research too. We do not generally realize that the Shakespearean and Elizabethan periods depended entirely upon wine for stimulation. Tea, coffee, and chocolate did not come into use until after Elizabeth, Shakespeare and Ben Jonson had all passed away.

ANTIQUITY OF BREWING

And now let us leave the respectable drinks for a short time and discuss one that is at present under the ban of the eighteenth amendment. The dictionary says that the word "beer" is of uncertain origin and that is the way the prohibition administrators feel about the product, so there is dissatisfaction all around. The reputed inventor of beer is usually referred to as Gambrinus. No such thing. Gambrinus is a corruption of Jan Primus or Jan I, a Flemish ruler who reigned over the province of Brabant in the latter part of the thirteenth century, and who was president of the Guild of Brewers and whose portrait was painted with a foaming tankard of ale in his hand. He had a good press agent.

Beer is much older than that. The word in biblical place names means a well, so that Beersheba, which everybody remembers as being some distance from Dan, has nothing to do with either beer or Sheba, for this particular name means "the well of the lions." Another case of misbranding under the Food and Drugs Act. Just like "near beer," for whoever was responsible for that name was a poor judge of distance. Ceres is said to have taught mankind the art of making beer when she was wandering over the earth in quest of her daughter.

Beer was known to the Egyptians, if we use the word in the generic sense, for the term was originally applied to a fermented decoction of cereals and still is used in connection with beverages of miscellaneous origins, as ginger beer, root beer, etc. The bitter, hop-containing beer was probably of Teutonic origin and was mentioned in connection with the tribes of Northern Europe by both Greek and Roman writers. Beer, porter, stout, and ale are all closely related products, differing in body, color, flavor, and alcoholic content. Ale and beer were at one time synonymous terms; as used at present the names describe quite different products. The word

"ale" originally meant a kind of feast or merry making, and we still use the root in connection with our word "bridal," which was originally the "bride-ale" or wedding feast. Of course this usage was derived from the fact that ale was the chief item of refreshment served at these gatherings.

They had church ales and college ales, too, in early England. The acknowledged purpose was to draw a lot of people together to collect money for the institution sponsoring such a festival. The people brought the food and the church wardens or college trustees furnished the ale—at a profit. In confirmation of this widespread practice a church at Norfolk bears the following inscription carved on its wall:

"God speed the plow
And give us good ale enow,
Be merry and glade
With good ale this work was made."

The word "potation" was used during the Elizabethan period to denote an annual entertainment (with beer as the principal feature) which was given by schoolmasters to their pupils, and an old statute of this period gives us a new insight into the relaxations of sixteenth century students and teachers. "The said schoolmaster shall and may have, use and take the profits of all such cockfights and potations as are commonly used in schools." Beer was so important an article in early England that they had official beer tasters, *gustatores cerevisiae,* who are responsible for the maintenance of the quality of the beverage.

Colleges usually brewed their own ale. The ales of Brasenose and Magdalen Colleges at Oxford were especially famous for their quality. The Chancellor's ale was of unusual strength and was used only at high table for guests who had taken especial honors. Two wineglassfuls are said to be a maximum allotment for safety's sake. On special occasions the Dean will grant an order for a pint, the largest quantity ever allowed. Here is a poem inspired by one of Brasenose celebrations:

"Shall all our singing now be o'er,
Since Christmas carols fail?
No! let us shout one stanza more
In praise of Brasenose ale.
A fig for Horace and his juice,

Falernian and Massic;
Far better drink can we produce,
Though 'tis not quite so classic.
Not all the liquors Rome e'er had
Can beat our matchless beer;
Apicius' self had gone stark mad
To taste such noble cheer."

Another Oxford author gives this ingenious theory of the evolution of malt and hop liquors:

"A grand cross of 'Malta' one night at a ball
Fell in love with and married Hoppetta the tall.
Hoppetta, the bitterest, best of her sex,
By whom she had issue the first Double X.
Three others were born by this marriage—a girl
Transparent as amber and precious as pearl;
Then a son twice as strong as a 'porter' or scout,
And another as 'spruce' as his brother was 'stout.'
Double X, like his sister, is brilliant and clear;
Like his mother, is bitter, by no means severe;
Like his father, not 'small,' and resembling each brother,
Joins the spirit of one to the strength of the other."

CARBONADE? And now let us turn our attention to "carbonade." What? You do not know what carbonade is? Perhaps you know what soda water is? Perhaps you know also that the term "soda water" is a misnomer, and that it contains no soda. Well, along about fifty years ago when soda water was in its infancy, some purist wanted to change the name, and as soda water is simply water impregnated with carbon dioxide, or carbonated water, he suggested the euphonious and perfectly appropriate name of "carbonade," and a contemporary writer, along about 1882, said "the term will probably be universally adopted in a few years." Another argument against making prophecies as to what will or will not become popular.

Well, to give the story of carbonade we must go back several hundred years and delve into the romance of chemistry for a few minutes. You know the ancients had conveniently agreed that there were but four elements—earth, air, fire and water. It was very simple and was so easy to learn. Along about the seventeenth century appeared an alchemist named J. B. Van Helmont, who was from Missouri so far as this "air" business was concerned. His experiments led to the

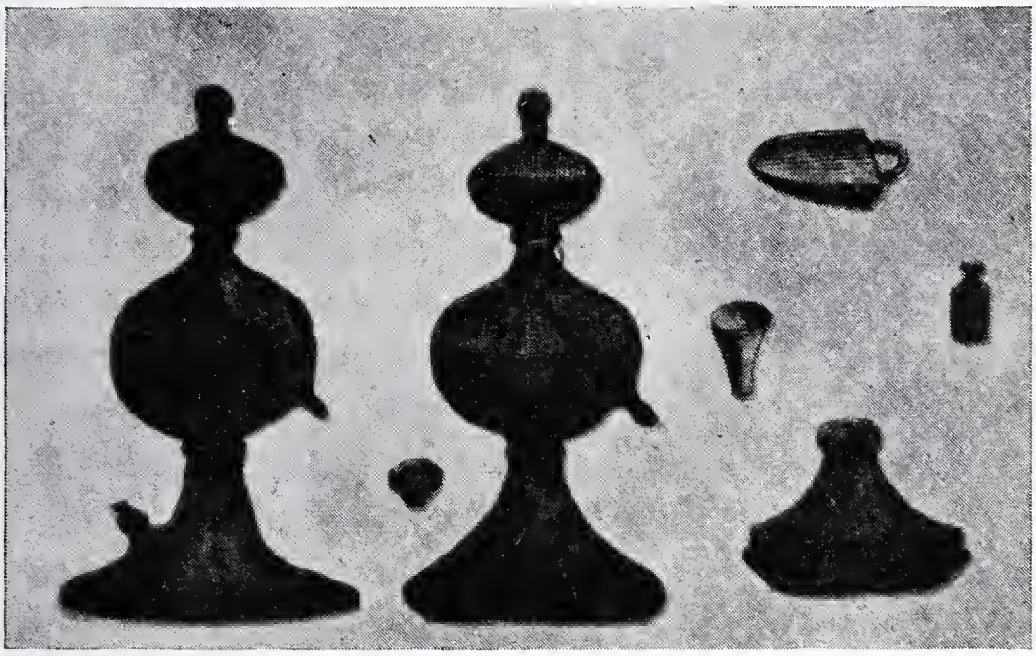
discovery of a new kind of "air" which he found naturally occurring in certain caverns, in the waters of effervescing mineral springs, and in the exhalations of decaying vegetation. He also found that he could produce this same kind of "air" by burning charcoal, by burning alcohol, by the action of acids on marble, limestone or oyster shells, and in the fermentation of wine or of beer. In consequence of these various sources he called it *"gas sylvestre,"* which, when literally translated means "the gas that is wild and untamed," like Kipling's cat that walked alone.

But wait—Van Helmont did more than this. He invented the word "gas." No one had ever seen or used or heard of the word before. Van Helmont literally pulled it out of the "air." He says of this invisible substance: "This spirit hitherto unknown, I call by the new name gas." Here then is one of the few words in the English language that has no family tree, no etymological history. Like Topsy, it "just growed." Van Helmont overlooked the very important fact that carbon dioxide is a small but ever present constituent of atmospheric air, but that is another story.

About one hundred and fifty years after Van Helmont's time, another chemist named Black reinvestigated this same gas and gave it a new name. He called it "fixed air." He did not approve of Van Helmont's work and wouldn't use the name gas. At about this time there was a famous grotto near Naples that was called the *Grotto del Cane* or Dog's Cavern, the air of which contained carbon dioxide in large amounts, and which was exploited for the delectation of visitors and the profit of the proprietors by throwing a dog into the cave attached to a rope. After the dog had become unconscious from asphyxiation he was hauled out and resuscitated, to the surprise and admiration of the spectators. The S. P. C. A. had no local branch in Naples, it is unnecessary to say.

In about 1750 a French chemist named Venel laid before the French Academy of Sciences a plan for duplicating Seltzer water which he had experimentally accomplished by mixing *sal aeratus* (literally, the "aerating salt," which was used at that time as leavening agent in culinary practice) with "marine acid," later called hydrochloric acid, with a certain proportion of water in a closed vessel. This product he called "aerated water," and when carefully made, with no excess of either of the original ingredients remaining unchanged, it closely resembled the natural Seltzer water, which is slightly saline and effervescent.

A few years later Dr. Joseph Priestley, the discoverer of oxygen, experimented with the exhalations of the brewery vats in Leeds, which was at that time his home. Can you picture this sedate clergyman leaning over the edge of a brewery vat pouring water briskly back and forth between two glass vessels in order that it might become impregnated with the gas and acquire the characteristic which we know as "sparkling," which is a phenomenon of effervescence or the liberation of a dissolved gas. Priestley claimed that by this procedure it was possible with ordinary water to communicate the peculiar spirit and virtues of "Pyrmont water," a natural spring water somewhat resembling Seltzer in its properties, but being less saline.



Early Portable Generator for Mineral Water or "Seltzer"

There were others who worked on this same subject and contributed to the facts which had been accumulating, and the time was about ripe for a commercial application of these principles, so we find that in 1790 an individual in Geneva named Nicholas Paul commenced the commercial manufacture of carbonated waters or "aerated waters" as they were then called. The practice soon became popular and spread rapidly.

The earliest record of soda water in America is in a Philadelphia pharmacy, the store of Townsend Speakman on Market Street near Second. Mr. Speakman, who was an ancestor of Professor Joseph P. Remington, for many years Dean of the Philadelphia College of Pharmacy and Science, was a pharmacist whose store was frequently visited by Dr. Philip Syng Physick, a famous Philadelphia physician

of a little over a century ago. Dr. Physick had been interested in Priestley's experiments upon carbonated water, and although Dr. Priestley had been dead for several years, Dr. Physick induced Speakman to prepare carbonated water for his patients in 1807. The first soda water served by a pharmacist in America, therefore, was served on a physician's prescription, and it is said that the addition of a fruit syrup to make the drink more palatable to the patient was the suggestion of pharmacist Speakman.

If a physician today wrote a prescription for *Aqua Acidi Carbonici,* for such was the Latin name of soda water in several of the pharmacopoeias of a century ago, he might have trouble in having it filled, for the pharmacist who could translate the prescription would not likely have a soda fountain. And wouldn't Van Helmont, Black, and Priestley be astonished to see a piece of "dry ice" or "carbice," as the solidified form of carbon dioxide is called, which is now coming into use for emergency refrigerating purposes?

And here we are, nearly at the end of the time allotted to our talk, and we have mentioned only a few of the more important of what may properly be called beverages. We have paid no attention to whisky or to brandy, which are spirituous liquors obtained by distillation. Brandy, literally *brannt wein* (burned wine), was the first spirituous liquor made in this way and was called *aqua vitae, eau de vie,* and other names indicating the esteem in which it was held. Indeed, Raymond Lully said of it is the thirteenth century: "The taste of it exceedeth all other tastes and the smell of it exceedeth all other smells."

These and other alcoholic spirits such as rum and gin (which derives its name from Geneva, which in turn is derived from Juniper which gives the characteristic flavor to this liquor) were often made in the household. The still room was almost as important as the kitchen or pantry and all of the medieval recipe books contained detailed directions for making many beverages and medicinal preparations by distillation, which was then a household art the same as weaving and dyeing.

All nations seem to have their own preferences and types of liquors of the more ardent varieties and so we meet sake, arrack, vodka, pulque, etc. The liqueurs, or cordials as they are usually called, are sweetened and diluted spirits and are of many flavors. They originated in the monasteries and genuine Benedictine and Chartreuse are still made under the supervision and control of the members of

these respective orders. There was a ribald drinking song of medieval times which, on account of its ecclesiastical flavor was supposed to have originated in a monastery. It ran like this:

"Come then, wench, and kiss us
Dum vivum potamus.
To Bacchus and Illisus
Te Deum Laudamus."

We do not have time to discuss fancy drinks or mixed drinks, for the list of these alone, if complete, would take another hour to call the roll. We may know what is meant by a cocktail or an aperitiv, and may have heard of and tasted egg-nog, but when it comes to a swizzle, a sangaree, a sling, a smash, or a sour, we may have to plead ignorance. Some of these, like the sherbet, the tisane, the shrub, and the vinegar, are non-alcoholic. We learn with surprise that "whiz" is another name for buttermilk, that "bever" is a sweet, aqueous liquid made by expressing the residue from cider or from grape juice after adding water to it. *Potus Imperialis* (Imperial Drink) sounds noble until we learn that it is made from cream of tartar, water and sugar, and then we lose interest in it. We are surprised to know that the "peg" of the Englishman in tropical India is so named because each one is supposed to be a peg in the coffin of the drinker thereof.

So many of these special drinks have interesting histories associated with their names. For instance, there is the "contradiction." You put a little whisky in to make it strong, then a little water to make it weak, a little lemon to make it sour and a little sugar to make it sweet, and finally, you pick it up and say "Here's to you," and drink it yourself.

I fear we shall have to take refuge finally in "Nepenthes," that famous potion which would assuage all grief and bring forgetfulness of sorrow, of which Milton sang when he said:

"Not that Nepenthes which the wife of Thone
In Egypt, gave to Jove-born Helena
Is of such power to stir up joy as this."

I am sure that none of you have developed a "Katzenjammer," the kind that inspired Eugene Field to write that memorable poem, of which one of the couplets runs:

> "How gracious those dews of solace that over my senses fall
> At the chink of the ice in the pitcher the boy brings up the hall."

Let us take our wee "Doch and Doris" or "Stirrup Cup" and part in friendliness. So beginning with the drinking salutation of the Caesars and coming gradually down to date:

Bene vos, bene nos, bene me, bene te,
Bene nostrum etiam.

or

Bene mihi, bene nobis, bene amicae nostrae.

or

Prosit.

or

Wass-hael

or

Gesundheit

or

Saluté

or

"Here's a health to you and all your family and may the skin of a gooseberry be big enough to make an umbrella to cover all your enemies."

SOIL AND SOD

By Dr. Arno Viehoever

Director of Biological Laboratories and Experimental Gardens

"A youth goes forth in merry whim
To keep appointment with the Spring,
And as he goes each living thing
Seems bent and bound to go with him."

OUR VERY EXISTENCE and subsistence is closely linked up with the soil and the sod we live upon. The soil must be alive to support vegetation, the vegetation must be healthy to nourish man. Vast areas of barren rock, desert sand, sterile bogs—all waste lands—suffer under the sentence starvation or death.

Dr. Arno Viehoever

The spirit of life must be present and must be kept active below the surface to furnish a vegetative cover above. The character and vigor of this cover depends much upon the condition of the ever changing, intricate mass—soil.

The last 100 years have brought us so much definite knowledge of soil and sod that man can now discuss the relation and almost claim control.

I

Earth Crust

1. SOIL FORMATION

Our globe shows a crust formation of soils or rock debris covering a hot interior of still unexplored nature and most of the eighty or more chemical elements discovered by man are found in this soil-forming crust and many, as we shall see later, represent important constituents of life plasma—involved, of course, also in the formation of sod.

While people generally call this debris "dirt," few actually are aware of the complex nature of soil and of the relationship of its composition to the cover it carries. Underlying all other rocks—we find probably always those originating from fiery condition—the original, igneous eruptive unstratified lava rocks and deposition in water; through the transformation into rock or rocklike masses of plant and animal remains, e. g., peat, lignite, coal, lime, coral, are formed the sedimentary, stratified, geologically very important rocks.

Either rocks may be further changed into metamorphic rocks, representing especially the schists.

Almost the entire land surface of the earth is covered by a layer of disintegrated and decomposed solid rock. This rock weathered mainly by changes in temperature and by solution under loss of much material, forms an accumulation of stone debris often mixed with plant and animal remains. Where the surface layer, through weathering of the rock and decomposition of the organic matter, represents earth favorable for plant growth, we refer to it as soil. Sub-soil is the material directly underneath.

Fig. 1. Rock Formation and Disintegration Into Soil. (After Hovey.)
a. Manhattan Schist with Glaciated Surface. (U. S. G. S.)
b. Earth Crust showing Disintegration of Rock. (U. S. G. S.)

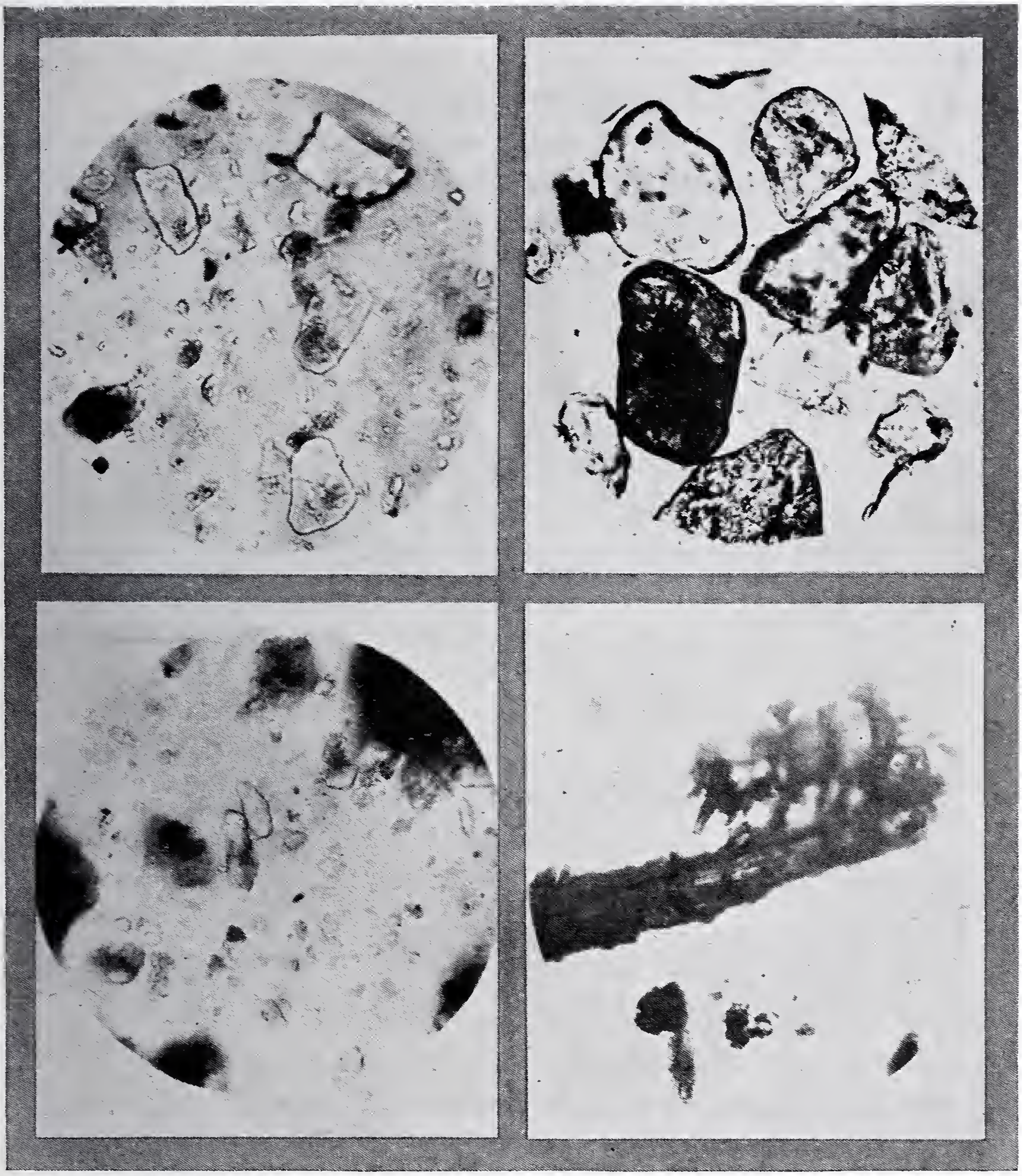
We find soils formed from granite, limestone, sandstone and shale. Marked differences exist between the soils according to the origin of the soil material as well as the factors which have changed that material into soil favorable to plant growth.

Muck and peat soils are formed in water filled depressions, lakes, ponds, without natural drainage—the wet conditions preventing complete decomposition of the organic matter.

SOIL COMPOSITION: ROCK—GRANITE

The oldest rock is granite, a most resistant stone, consisting of quartz (sand), mica, and feldspar—a double silicate of aluminum and alkali (sodium or potassium) metal. The gnawing tooth of time wears down this rock; water and carbon dioxide break down the feldspar.

The salt of the alkali metal is removed, leaving the aluminum silicate and water, chemically bound as clay. The quartz is liberated as sand, forming some sort of soil. View any solid rock, even the Hudson



a

c

b

d

Fig. 2. Soil Constituents.
a. Disintegrated Schistose Rock, Showing Crystalline Structure Predominant.
b. Sand, Crystalline With No Organic Matter.
c. Clay, Showing Crystalline and Organic Structure.
d. Humus, Organic, Showing No Crystalline Structure. (Photos by Lewis.)

Palisades—and you see the tooth of time, the consequence of much decay, still more debris, clay, and sand and loam—the making of a better soil.

CLAY The weathered rock, representing hydrated silicate of aluminum together with the oxide and the acidic silicon dioxide, forms all kinds of clay, from white (kaolin) to grey —blue—red to mud. It is the storehouse for the fossils of great variety, the provider of some life—though "clay soil on farms bakes hard."

SAND Bleak sands of the sea of dunes and desert are fair examples of the ordinary sand, the silica, the dioxide of silicon. It is the other surface of the crust of earth, remaining after clay and mud are washed away, as more resistant to decay and change—a filter, not a sponge, poor indeed if used as soil alone.

HUMUS The organic portion of the soil, in progress of plant or animal decay, is humus. We speak of humus, when we mean the mass of rotting fallen foliage; of humus or of peat, when we make reference to bogs or marshes—swamps, where grass or mosses are submerged for centuries, the lack of oxygen preventing complete decay. The sphagnum mosses thus yield acid peats, almost devoid of nitrogen, the sedgegrass yields neutral peats quite high in nitrogen, both highly absorbent.

2. SOIL TYPES Origin and texture of the soil and size of the particles determine the soil unit or soil type. Soils are consequently divided into stony soil, sand, fine sand, sandy loams, fine sandy loams, loam, silt loam, clay loam, silty clay loams and clays, muck and peat.

The United States Bureau of Soils recognizes the following classes for mineral soil materials:

Class						
I	Particles	smaller in diameter than	.005		millimeter,	clay.
II	"	ranging between	.005 and	.05	"	silt.
III	"	" "	.05 and	1.0	"	sand.
	"	" "	.05 and	.1	"	very fine sand.
	"	" "	.25 and	.5	"	medium sand.
	"	" "	.01 and	.25	"	very fine sand.
	"	" "	.5 and	1.0	"	coarse sand.
IV	"	" "	1. and	2.	"	fine gravel.
V	"	larger than	2.		"	gravel.
	"	" "	gravel			cobbles.
	"	" "	cobbles			stones.

Davis and Bennett, soil workers of the United States Department of Agriculture, recently arranged, besides special soils, twenty principal and subordinate soil classes based on mechanical composition and texture and grouped them into three major classes according to clay content, namely:

General Soils

I	Soils containing less than 20% clay:		
	a—Soils containing less than 15% silt and clay	:	Sand.
	b— " " from 15 to 20% " " "	:	Loamy sand.
	c— " " " 20 to 50% " " "	:	Sandy loam.
	d— " " 50% and more " " "	:	Loam and silt loam.
II	Soils containing from 20 to 30% clay	:	Clay loam.
III	" " 30% and more	:	Clay.

Special Soils

I	Soils containing 65% or more organic matter *(sometimes mixed with silt, clay)	:	Peat.
II	Soils containing 20 to 25% organic matter *(and sand, silt, little clay)	:	Peaty loam.
III	Soils containing 25 to 65% organic matter *(and muck clay, silt, sand)	:	Muck.
IV	Soils containing 30% or more of gravel up to 4½ inches in diameter	:	Gravelly soil.
V	Soils containing enough stones over 4½ inches in diameter to hinder cultivation	:	Stony soil.

3. SOIL PROFILES Veatch, of the Michigan Agricultural Experiment Station has discovered four general textural and structural profiles. He found

(1) that the surface layer of the virgin soil, in which there has been an accumulation of humus is higher in elements of fertility and less strongly acid, particularly in the heavier soils than the horizon of mineral soil directly beneath it;

(2) that there is a horizon of variable thickness, which lies just beneath the mold or humus soil, which represents maximum leaching and removal of the more soluble constituents, while at a shallow depth the soil reaches a point of maximum acidity;

*The field soilworker rubs the soil material in his hand to determine by the feel the pliability of the moderate moist clay soil, the good friability of other soils, the texture as light, sandy, heavy or clay, silty, loamy, clay loamy, etc.

(3) that lime or calcium carbonate has been leached or removed generally to depths of two to five or six feet; that the removal has taken place to greater depths in the sands than in the clays; that the substrata are universally calcareous or alkaline in reaction, most markedly so in clay and gravel, less so in sand;

(4) that there is a horizon (soil layer) at variable depths, but above the substratum, in which there is a maximum amount of clay and colloids, due either to weathering in place or to concentration or to both.

The profile analysis has an interest and significance not only to the scientist in soil classification, but also to the farmer who cultivates the staple general farm crops, the horticulturist, the forester, the

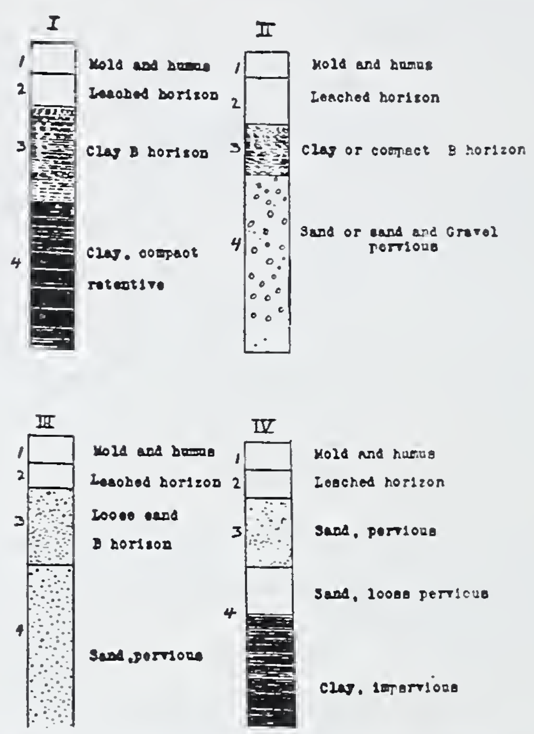


Fig. 3. Soil Profiles. (After Veatch.)

drainage engineer and the highway engineer. Certain soil types belonging in I and II profiles for example, may exhibit an acid plow soil, yet support a good growth of legumes when the roots have penetrated to the limey or alkaline soil which lies at shallow depths, while on certain types belonging to No. IV profile the plants may fail both because of greater depth to lime and greater acidity. Trees may send roots down to the clay substratum in the IV profile and exhibit a good growth on what is apparently an infertile sand, while on a type belonging in profile III the growth of the same species may be poor and the tree shorter lived. On certain soil types of this state, roots of trees have been observed to extend to depths of as much as fifteen feet, while on certain other soil types comprised in profile I, the roots of trees may flatten out at depths of only two or

three feet. The roots of grasses, clover and alfalfa have been observed to penetrate to depths of two to four feet or more. The average content of moisture or water is relatively high throughout the year in soil types comprised in profile I, while it is relatively low in profiles II and III and the movement of water freer. Soil types of sand texture in IV may appear dry at the surface, yet contain abundant moisture at shallow depths on account of the clayey and impervious nature of the deep substratum.

A knowledge of the virgin profile enables us to understand better the changes which have taken place in the plow soil due to cultivation. In many instances, due to erosion, horizon 3 of profiles I and II comprises the greater part of the plow soil which must differ markedly in plant response and tilth from the original top soil. Probably in most soils, the present plow soil represents a mixture of two or even three separate members or horizons of the virgin soil. Even in a forest or cut-over land the overturning of large trees may bring to the surface horizons of mineral soil quite unlike the virgin mold and humus in effect upon the plant, so that the growth of a seedling may be different in one spot as compared with another only a few feet away.

4. SOIL REACTION In the intimate relation of soil and sod, soil reaction plays an important role. The physical conditions, the chemical changes and the type and vigor of the soil population, the life of the soil, are greatly affected by the reaction of the surrounding medium. Ideal soil conditions in turn are the main basis for luxuriant plant growth.

A soil containing freshly rotting leaves of oaks, bark, pine needles, spruce or hemlock, acid peat, plowed under crops, usually turns sour (acid). In contact with limestone rock its reaction changes. Lime (limestone or marl) added to sour soil makes the soil neutral or sweet (alkaline). Ammonium sulphate, aluminum sulphate or tannic acid added to sweet soil neutralize the alkali and then sour the soil.

Water (H. O. H.), necessary for all changes of reaction, is electrolytically dissociated in equal numbers, if neutral, of electrified hydrogen (H) ions and hydroxyl (OH) ions. Actual excesses of OH ions are responsible for the degree of alkalinity, excesses of H ions for degree of acidity. These ion concentrations can be determined either colorimetrically with special indicators or electrometrically with potentiometers, registering the degree of electrical conductivity.

The values found by agreement are expressed as the potential due to hydrogen : ph; defined as the logarithm of the denominator expressing the normality of hydrogenions as normal tenth-—normal hundredth, etc. The hydrogenion concentration of pure distilled water is normal/10,000,000 th. gram equivalent of hydrogenion; the ph value therefore would be 10,000,000, which is 7, the neutral point of the ph scale.

In this country Dr. Wherry, of the United States Bureau of Chemistry and Soils, has collected, mostly through field tests, a large number of data on soil reaction preferences of plants. He also suggested a certain nomenclature which has been adopted in the scale and statements of his findings utilized in this paper.

Scale

SOIL REACTION IN HYDROGEN ION CONCENTRATION (pH)

ACID—(SOUR)			CIRCUM—(NEUTRAL)			ALKALINE—(SWEET)		
3.1—4.0	4.1—5.0	5.1—6.0	6.1—6.9	7.0	7.1—7.9	8.0—8.9	9.0—9.9	10.0—10.9
Super Acid	Medi Acid	Sub Acid	Minim Acid	Neutral	Minim Alkaline	Sub Alkaline	Medi Alkaline	Super Alkaline

SOIL REACTION SCALE

A soil showing a ph value of 6-8, the circum-neutral zone, furnishes the best physical conditions for most plants. In acid bog soil organic acids have accumulated, causing ph values as low as 4 and 5. In alkaline acid or semi-acid soils sodium carbonate may accumulate changing the soil to a reaction as high as 9 and 10 ph.

5. SOIL LIFE A very ancient form, never absent in a fertile soil, but visible only with the microscope, is known now as belonging to the class of micro-organisms, called bacteria. Some bacteria are definitely responsible for the fertility of the soil, serving as middle men in the nutritive chain. Jordan found in one gram of soil:

25 fixing nitrogen of the atmosphere, forming nodules on roots, wherein nitrogen substances are transformed.

7500 nitrifying, building up nitrogen compounds.

50,000 denitrifying, breaking down such compounds.

50,000 urea bacteria, decomposing the urea of manures and fertilizers in ammonia and carbon dioxide.

1,750,000 peptone decomposing bacteria, breaking down proteins to ammonia and other compounds.

Ammonia and its compounds are evidently not themselves assimilated by plants to any extent. They are first oxidized due to the action of nitrite forming bacteria as nitrosomonas into nitrite which then is transformed into nitrate by the nitro-bacter bacteria. These nitrifying organisms develop upon inorganic substances and appear to utilize the atmospheric carbondioxide for their supply of carbon. These nitrates and nitrites may be reduced again to ammonia, to oxides of nitrogen and free nitrogen, by the denitrifying bacteria of the soil, if conditions are favorable such as presence of nitrates, readily decomposable organic material, suitable temperatures and want of tillage.

However, soil life is not restricted to multitudes of bacteria. Soil workers connected with the Rothamsted Experiment Station have counted also the numbers of animalcules, protozoa, lowest forms of microscopic animals, as amœbæ, flagellates and ciliates. Their data represents the average numbers obtained in the high activity period of the spring and the low activity period of the winter.

SOIL-POPULATION

	Number per gram of soil	*Approx. weight lbs. per acre*
Bacteria—High Activity	45,000,000	50
Low Activity	22,500,000	25
Amœbæ—High Activity	280,000	320
Low Activity	150,000	170
Flagellates—High Activity	770,000	190
Low Activity	350,000	85
Ciliates—High Activity	1,000	—
Low Activity	100	—

MOLDS

In soil as well we find the fungi or molds, the comrades of roots and fallen leaves and stems assisting decay of highly organized compounds, helping conduction of the mineral food, destroying here, building there, active, even replacing roots and rootlets in their development as "mycorrhiza," which we find in an increasing number of cases benefiting plant growth.

a b c d

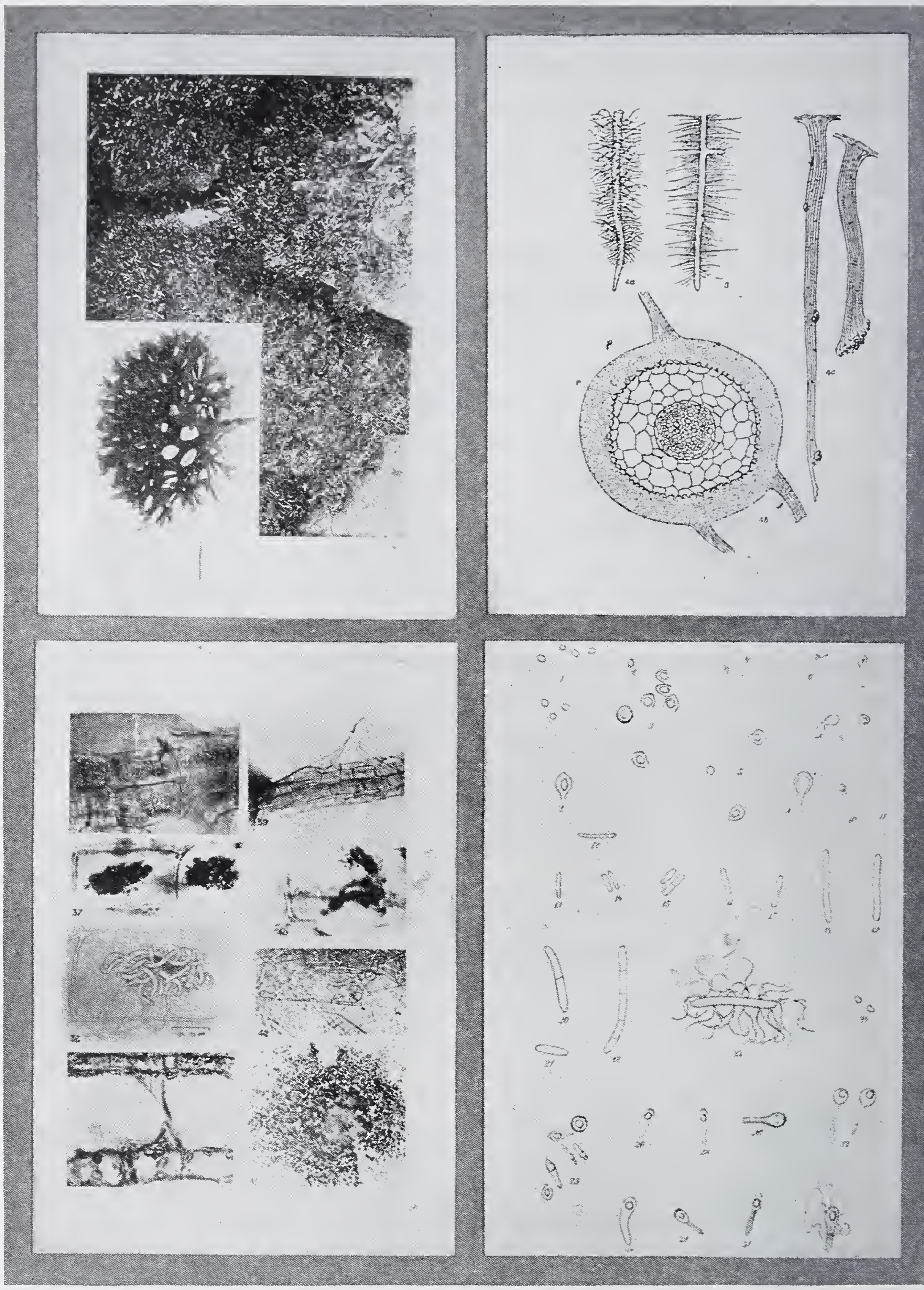


Fig. 4. Soil Population.

a. Irish Moss Growing on Massachusetts Rock. (After Tressler.)

b. Root-hair- and Mantle-like Fungi (Mycorrhiza)., Growing on Root of Beech (3), and South African Pine (4). (After Frank.)

c. Penetration of Mycorrhiza Into Plant Cells of Hosts, Where They Are Digested and Agar Cultures. (After Rayner.)

d. Soil Bacteria (Urea Bacillus), by Viehoever.

LICHENS Molds grown in close companionship with algæ life form a very ancient group living a slow and often starving existence. We find them almost everywhere, in the frigid zone as well as in the tropics, on rocks, on soils, on barks, and stumps, in the dark moist surface of the forest floor as in sunlighted spots of the open spaces. Lichens are indeed resistant organisms, adapted to certain restricted moisture and nutritional conditions. They, too, assist in their way in the breaking down and building of soil and plant food elements.

ALGAE These forms, profiting as we have seen, under certain conditions of want from their association with molds, live also as individuals. The green and blue-green algæ belong indeed to the simplest living plants. They live in water or in wet places, and are considered to have been associated with the earliest fossils. Similar animal life, occurring in the soil and water, evidently still depends upon such algæ. These use their green and blue-green pigments to build up their carbon compounds from the carbon dioxide of the atmosphere with the help of sun energy. They enrich in these and other ways the organic as well as inorganic food materials.

ANIMALS Besides the lowest forms, the protozoa, we find worms, garden snails, and various stages of insect life, other useful agents in the soil. They stir, aerate it, keep it mixed and often fertilize it with their manure and worn out bodies.

These organisms mentioned convert the organic matter in the soil, the plant remains and manures into useful plant foods. They produce nitrates, valuable soil colloids from plant and animal materials and non-toxic end products from intermediate substances.

SOIL DISINFECTION While all these forms of life in soil are noted for their share for good, an excess or the presence of unwanted types may upset all the happy balance of soil for sod and do an untold harm, causing disease, destruction and decay of plants and crops. Tired soils are those yielding, after years of fertility, very poor crops—unless purified, that is partially sterilized. This partial sterilization is effected with heat (steam) at temperatures of 80 to 100 C., or with chloroform, carbon disulphide, toluene or ether. It is believed that this soil disinfection not only removes excessive and unwanted micro life, but that certain toxic substances accumulated in the soil may be destroyed and that wax-

like remains of micro life, enclosing the humus particles, will be dissolved by this treatment.

The humus will then again be available for renewed growth of micro-organisms. Whatever the detailed causes, it is an evident fact that partial disinfection restores the balanced micro life and fertility of the soil.

6. SOIL FERTILITY

The secret of fertility hidden in the soil, the clothing blanket of the earth, has engaged the attention of many earnest workers from primitive man to the ablest of living scientists. One clue after another has been disclosed so that we can today quite definitely mention the following as essential factors involved in the fertility of the soil.

1. Soil constitution; the presence of certain soil elements, chemical plant food elements and the organic humus.
2. Soil texture; the adequate preparation.
3. Soil tillage; the appropriate condition.
4. Soil reaction: the acceptable concentration of hydrogen ions.
5. Soil life, the suitable micro population and activity.
6. Soil moisture, the necessary supply.
7. Soil climate, the desired temperature ranges.
8. Plant: the right kind for particular soils.

Of the eighty and more chemical elements known the following have been quantitatively isolated.

TABLE I

Elements in the Earth Crust *

	%		%
Oxygen	46.46	Chlorine	.05
Silicon	27.61	Bromine	....
Aluminum	8.07	*Phosphorus*	.12
Iron	5.06	*Sulphur*	.06
Calcium	3.64	Barium	.04
Magnesium	2.07	*Manganese*	.09
Sodium	2.75	Strontium	.02
Potassium	2.58	Nitrogen	....
Hydrogen	.14	Fluorine	.03
Titanium	.62	All other elements	.50
Carbon	.09		

* Determined by F. W. Clark.

However, not all of these serve as plant food. In fact, only about 15 per cent. of an average good soil can ever become plant food, according to Professor Truog, of the Department of Soils of University of Wisconsin. The remainder of the soil material is important, however, as it makes up the framework of the soil, gives it favorable physical structure and pore space. It provides stability for the plant, necessary aeration for the entrance, movement and exchange of water and gases—essential for the growth of roots.

TABLE II

Elements in Living Protoplasm *

Oxygen	72.0%	Hydrogen	9.1%
Carbon	13.5%	Nitrogen	2.5%
Sulphur, Phosphorus, Chlorine, Sodium, Potassium, Calcium, Magnesium, Iron, Silicon, Fluorine, Iodine, Manganese, traces	together less than 3%		

These elements, with the possible exception of sodium, are accepted as essential plant food elements. Boron must be added as essential to plant life—and copper for certain soil as the Florida peat soils. Copper sulphate added at the rate of forty to fifty pounds per ton of fertilizer has produced in some sections striking increases in crop returns.

Many of the essential elements are needed in such small quantities by the plants that due to their abundance in either soil or atmosphere they hardly need ever to be replaced.

AIR DERIVED ELEMENTS

The supply of oxygen and carbon, primarily present in the air as carbon dioxide, is practically inexhaustible, though increase in the amount of carbon dioxide over that usually present in nature (soil or air) benefits plant life. Nitrogen, abundantly available in the atmosphere, may be secured directly by certain microscopic organisms, commonly found in soils, and in part associated with the roots of leguminous plants, as beans, clover, alfalfa. Plowing under of these crops enriches the soil with nitrogen for non-legumes.

*C. Wood.

SOIL DERIVED ELEMENTS

The amount of aluminum and iron, according to soil surveys of Iowa and other regions, remain practically constant. Potassium, while generally present in normal soils, is usually lacking in peats and swampy soils. It must be added to soils, upon which tobacco is grown. Calcium, so necessary in the formation of the plant skeleton and so desirable often in the correction of soil reaction, is rarely altogether lacking. Soil bearing crops of legumes, clover and alfalfa in particular, require more lime than others. Magnesium, considered unnecessary until recently, is now recognized as an essential. Sulphur, evidently absent in many soils, appears of value in the growing of certain crops though its function in soil fertility is not fully understood. Carbon liberated in the soil as carbon dioxide is an essential ingredient of fertile soil. Carbon is the basal element of all organic substances, furnishing the building stones of cell wall and cell contents: protoplasm, sugars, starch and proteins.

AVAILABILITY

The plant food elements however are only available to plants in the dissolved condition. Consequently plants will suffer for lack of food, unless the food elements are soluble or the micro-organisms, the agents of soil life, change the unavailable insoluble material into the usable, soluble form. As a result plant food is removed from the soil by both crops and by leaching. That the amount of food elements found in various farm crops is considerable is evident from data given in Table III.

TABLE III

Plant Food in Crops and Value—Jefferson County Soils

		Plant, Food, Lbs.			Value of Plant Foods			Total Value of Plant Food
Crop	Yield	Nitrogen	Phosphorus	Potassium	Nitrogen	Phosphorus	Potassium	
Corn, grain	75 bu.	75	12.75	14	$12.00	$1.52	$0.84	$14.37
Corn, stover	2.25 T.	36	4.5	39	5.76	0.54	2.34	8.64
Corn, crop	....	111	17.25	53	17.76	2.07	3.18	23.01
Wheat, grain	30 bu.	42.6	7.2	7.8	6.81	0.86	0.46	8.13
Wheat, straw	1.5 T.	15	2.4	27	2.40	0.28	1.62	4.30
Wheat, crop	....	57.6	9.6	34.8	9.21	1.14	2.08	12.43
Oats, grain	50 bu.	33	5.5	8	5.28	0.66	0.48	6.42
Oats, straw	1.25 T.	15.5	2.5	26	2.48	0.30	1.56	8.28

Crop	Yield	Plant, Food, Lbs. Nitrogen	Phos-phorus	Potas-sium	Value of Plant Foods Nitrogen	Phos-phorus	Potas-sium	Total Value of Plant Food
Oats, crop	....	48.5	8	34	7.76	0.96	2.04	14.70
Barley, grain	30 bu.	23	5	5.5	3.68	0.60	0.33	4.61
Barley, straw	0.75 T.	9.5	1	13	1.52	0.12	0.78	2.42
Barley, crop	....	32.5	6	18.5	5.20	0.72	1.11	7.03
Rye, grain	30 bu.	29.4	6	7.8	4.70	0.72	0.46	5.88
Rye, straw	1.5 T.	12	3	21	1.92	0.36	1.26	3.54
Rye, crop	....	41.4	9	28.8	6.62	1.08	1.72	9.42
Potatoes	300 bu.	63	12.7	90	10.08	1.25	5.40	17.00
Alfalfa, hay	6 T.	300	27	144	48.00	3.24	8.64	59.88
Timothy, hay	3 T.	72	9	67.5	11.52	1.08	3.95	16.55
Clover, hay	3 T.	120	15	90	19.20	1.80	5.40	16.40

Calculating Nitrogen (N) at 16 cents (Sodium Nitrate ($NaNO_3$)); Phosphorus (P) at 12 cents, Acid Phosphate, and Potassium (K) at 6 cents (Potassium Chloride (KCl)).

The loss of fertility depends upon the type of farming, live stock, dairy or grain farming. Where no manure is produced and the whole grain crop is sold—as in grain farming, the soil very quickly becomes depleted in essential plant foods. Constant cropping alters the soil chemically and biologically. Experience has shown that soils may be kept permanently fertile by controlling the moisture in the soil, by crop rotation, by replacing the deficient mineral and organic plant foods, through manuring and fertilizing.

An oversupply of fertilizer, especially chemicals which are readily soluble, will give such a heavy concentration to the soil water that it becomes more dense and more concentrated than the sap within the individual cells of the roots. The result is the reverse of the usual procedure, inasmuch as the sap diffuses out of the cells, and they thus lose their water content. This causes them, in turn, to take the water from the rest of the plant, causing wilting.

MOISTURE The soil moisture is one of the most important factors governing crop production. In too dry soils plants suffer for lack of water, containing the food, as well as of available plant food; the production of available plant food ceases, as bacterial life and activity becomes restricted. In too wet soils plants suffer, through leaching out of plant food or for lack of air

and available food, since decay is checked, beneficial bacterial action is limited and unavailable organic matter accumulated.

Cultivation, drainage or irrigation are the most important farm operations keeping the soil in the best condition for crop production. The moisture may be conserved in the soil by frequent hoeing and the maintaining of a good mulch. The nature of the surface soil and especially of the sub-soil determine largely the need for drainage. With heavy tight clay as a sub-soil a surface layer of clay loam will be much affected by excessive rains; a sandy surface will be prevented from rapid drying out and ready losses through leaching. Especially effective in the absorption and retention of moisture and plant food elements, thus preventing ready leaching, is the presence of humus in the soil.

Commercial Fertilizers

Besides the well-known manures; horse, cow, sheep, poultry, bird and bat fresh, dried or shredded, powdered, we find in commerce chemical and organic fertilizers containing two or three of the essential plant foods, the nitrogen, phosphorus and potassium fertilizers.

	Nitrogen Fertilizers or Carriers			
	Nitrogen (N)	Ammonia (NH_3)	Phosphoric Acid (P_2O_5)	Potash (K_2O)
Sodium Nitrate natural or manufactured (Chilisaltpeter)	15–16%			
Ammon. Sulph. nitrate (Leuna saltpeter) manufactured	26%	31.5%		
Calcium nitrate (28% Lime) manufactured	15.5%	18.8%		
Ammon. sulphate	20%	25%		
Ammon. phosphate or other preparations	20%		20% Avail.	
Calcium cyananide	15%			
Urea	46%	55%		
Dried blood meal		11–17%		
Meat meal		12–14%	1–5.9%	
Animal tankage	4–9%	7–12%	3–12%	
Fish meal		8–12%	4–8%	
Castor pomace		5–8%	1–5%	1–5%
Cottonseed meal		7–9%	2.5–3.5%	
Activated sludge		5–7.5%	7–20%	0.5–1%
Bone tankage or other proportion	4–12%		2–5%	
Garbage tankage		3–4%		

Phosphorus Fertilizers

	Nitrogen (N)	Ammonia (NH_3)	Phosphoric Acid (P_2O_5)	Potash (K_2O)
Phosphate rock (66–75% or 75–80% Calcium phosphate)			20–28% mainly unavailable	
Acid phosphate (available calcium phosphate) and calcium sulfate (Gypsum)			14–19% available 0.5–2% insoluble	
Super phosphate (double or treble)			40–50% available 0.5–4% insoluble	
Basic slag (Thomas slag)			11–25% much available or 16–19% much available or over 12% (80% soluble) 2% citric acid	
Bone meal (50–55% calcium phosphate)			22–28%	2–3%
Nitrophoska (balanced fertilizer)	15%		30%	15%

Potassium Fertilizers

	Nitrogen (N)	Ammonia (NH_3)	Phosphoric Acid (P_2O_5)	Potash (K_2O)
Kainit (Nat. deposit with potassium muriate)				12.4–16%
Potassium muriate				50–50.5%
Potassium sulphate				40–50%
Tobacco stem		2–4%		4.9%
Hardwood ashes (unleached)				2–8%

Lime Fertilizers

Calcium carbonate with 56% lime (CaO); 44% carbon dioxide.
Lime stone, marble, oyster shells.
Marl (natural deposit) often containing 75 to 95% calcium carbonate.
Calcium oxide—Lime, burnt lime with 80–95% lime (CaO); 1–5% carbon dioxide. Quick lime.
Calcium oxide (hydrated) with 60–80%; 20–30% water.
Hydrated lime.
Calcium sulphate (hydrated); (gypsum).

Lime (calcium) is often considered only as an indirect fertilizer though it functions in the structural upbuilding of the tissue. It neutralizes harmful soil acids, aids nitrification, reduces crust formation of loam soil; as limestone it enriches the soil in carbon dioxide.

To increase its usefulness and that of other plant foods, manufacturers of fertilizers combine it with forms of nitrogen as nitrates or urea, or with phosphorus.

CARBON AS FERTILIZER

The gasing with carbon dioxide as the only available form of carbon has been carried out with marked results of increased growth in commercial greenhouses. The amount normally obtained in the process of assimilation was thus increased to assist the metabolism. The increase of carbon dioxide in the soil hastens the solution of otherwise insoluble soil minerals as phosphates and potassium salts. It thus opens the soil, making it granular and loose, permitting aeration and transformation of harmful iron salts.

Carbon dioxide serves as an effective buffer, aiding in the prevention of excessive acidity and alkalinity. It is liberated not only from carbonates and urea but also from green manure, crop residues, farm manure, other organic fertilizers and decomposable organic substances as leaf mold or available humus.

Dried commercial humus contains about 60 per cent. carbon and 3 to 4 per cent. nitrogen, transformed under favorable soil and balanced food conditions by soil life into available carbon and nitrogen compounds.

Humus is also one of the most important soil colloids, that is, substances which increase absorption of plant nutrients, water holding capacity and surface area of soil-forming constituents.

LAW OF MINIMUMS—PRINCIPLES OF RATIOS

In spite of the beneficial effect of early added plant food to the general soil fertility, the law of minimums, suggested already by J. Liebig, prevails. As every nutrient as well as growth factors (heat, light, water, air) have a distinct and specific effect and as the missing factor cannot be replaced by any other, growth consequently is limited bv the substance or factor least available.

Certain relations between food elements have been quite definitely established and designated as nitrogen-carbon ratio and nitrogen carbohydrate ratio; thus the accumulation of nitrate in the soil is determined largely by the abundance of organic material (carbon)

present. The ratio of carbon to nitrogen averages about *1:10* in our soils.

Too heavy application of nitrogen fertilizers, disturbing the nitrogen carbohydrate ratio, result in excessive vegetative growth of crops at the expense of the root system, while the opposite effect results in nitrogen deficiency.

II

Magic Carpet

1. JUNGLED JUNGLE

The tropical jungle is pictured to us as a forest of wilderness of towering as well as fallen tree trunks (filled with parasites), supporting countless creepers —climbing and crawling in all directions, halting the foot of man at every step—jungle, an impenetrable tangle of trees, bushes, vines and briars, a veritable hell, in which man without axe and hatchet is hopelessly lost.

Favorable temperature and high humidity and an abundant micro life in both atmosphere and soil, all contribute to the rapid and irresistible growth. The soil through this rapid decay of organic growth is greatly enriched in important essentials, especially in organic compounds and humus. Carbon dioxide, available in increased amounts to the breathing pores of plants, both from the air as well as soil, likely is an important factor contributing to the splendid horror, confronting or surrounding man, lost in the jungle.

2. WELCOME WOODS

Similar conditions may prevail in our virgin forests, though growth there is less wild or rapid. The primitive redwoods, the pines of Maine and other forested regions display their majesty more freely to man. The needles of pines, hemlock and spruce make the soil face sour, causing reaction, unfavorable to many other plants. Fresh oak leaves also sour the soil and we, in consequence, do find these oaks and other acid loving plants as heath predominate, yes, exclusively exist in acid soils.

The leaves of other trees as beech and maple cause no marked change in soil reaction, the ph values found were six to eight, a range preferred by the majority of plants.

Most woodland soil is acid, few woodland trees caring for much lime; juniper, yew, arbor vitæ, common cypress, maple, beech, buckeye, ash and elm prefer an almost neutral soil.

Some plants, few mosses and mushrooms grow on limestone cliffs, where during certain stages the soil reaction may be expected to be somewhat alkaline. Some others of these forms prefer an acid soil; thus certain mosses may be used as indicators for acid soil—though these indications may require checking as the same types do good on soil in want of nitrogen.

All woodland plants are accustomed to rich nourishment supplied largely by the heavy leaf mold, constantly forming on an already good loam; this leaf mold may become so deep that many plant roots never reach far into the sub-soil below.

Fig. 5. Earth's Garment.
Leaf Mold and Lichens on Surface of Forest Soil (from Rayner "Mycorrhiza").

Trees as the hemlock and maple with their spreading surface roots keep the grounds about them very dry; those that strike deep with but one tap root draw their main supply from the sub-soil and leave a fair amount on the surface. A spreading root system drains the soil most heavily underneath the outer branches. Plants will best grow close to the trunk or beyond the branch radius. In the case of tap rooted trees, draining the soil underneath the trunk, plants thrive better outside the tree area.

Most woodland plants prefer moist places, protected from prolonged exposure to direct sunlight and wind. If we would enjoy a

Average Botanical Composition of Pasture Vegetation as Influenced by Fertilizers, Lime and Manure

Bradford County—Volusia Soil—1918-1927.

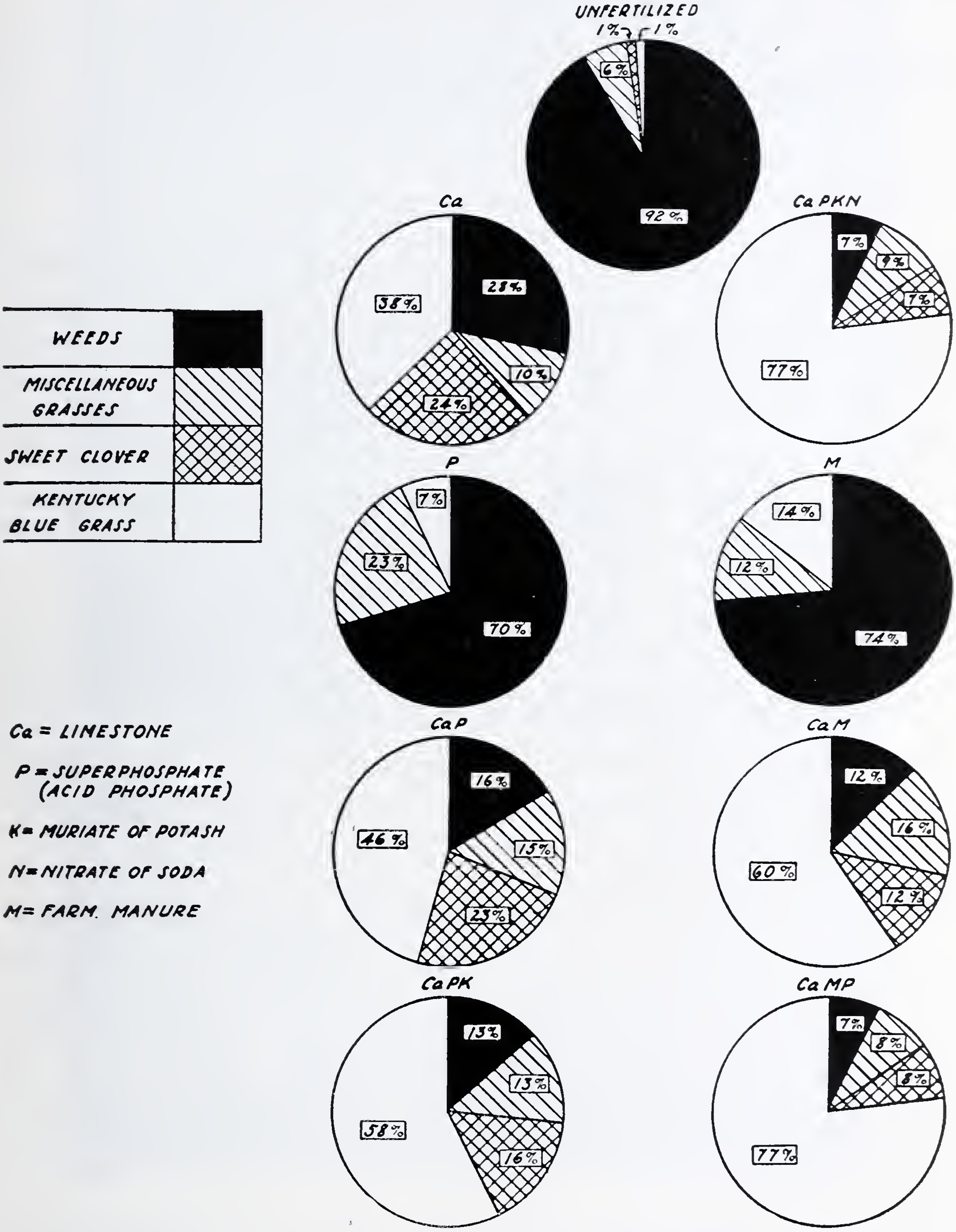


Fig. 6. In the Production of a Permanent Kentucky Blue Grass Pasture on Westmoreland Soil, Lime Shows Clearly Its Value in Paving the Way for the Profitable Use of Commercial Fertilizers and Manure. Both the Complete Fertilizers and Manure Plots Reinforced With Superphosphate Have Produced a Pasture Practically Free From Weeds, Containing From 95 to 96 Per Cent. of Pasture Grasses.

touch, a feeling of woods in our gardens we must furnish such conditions to the trees, the ferns, the woodland lilies, solomon seals, trilliums, foxgloves, lady slippers and the vines.

3. PLEASANT PASTURES

While in undrained areas as swamps and peat bogs we usually find a stunted and restricted growth (as either sphagnum moss, sedge, or saw grass or certain other seeds and grasses) in meadows, where conditions greatly favor growth, we find a wealth of plant varieties.

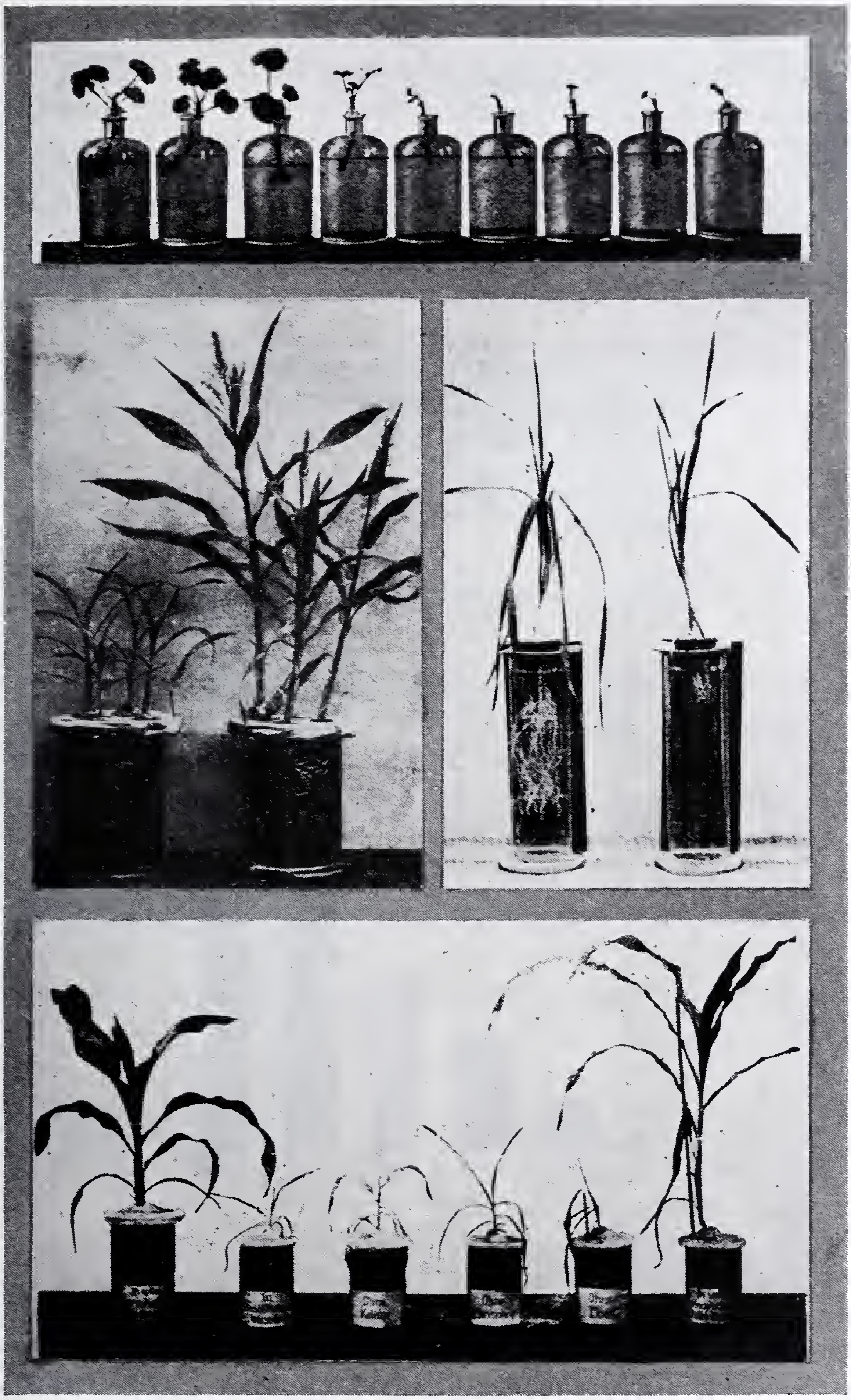
The types of plants taking food and holding on depends of course much on the nature of the soil and the environment. The vigor of growth, as aforesaid, depends upon the presence, concentration, choice of needed elements, and then still further on the soil reaction and soil life. The influence of judicious use of fertilizers, lime, manure, tested over a ten-year period and illustrated here, is striking and remarkable.

The grasses giving our best pastures and yielding our best forage crops generally also give good turfs. They are discussed under turf grasses.

4. FERTILE FIELDS—CROPS

The selection of the crop or crops suited to the soil is even mcre important in the case of fields, planted and cultured. Much available progress has been accomplished on the relation between crop and soil, on best suited texture and most effective fertilizers. Indeed one worker, Davidson, has shown that nitrogen in certain forms applied at a later stage of growth increased the protein content in grain.

The need of plants for definite plant foods may be readily demonstrated by growing them in mineral free distilled water and in nutrient solutions with and without certain essential elements. Lack of potassium affects leaf growth and leaf strength; lack of phosphor affects leaf growth, especially seed forms; lack of iron interferes with the development of the green plant pigment. The stimulating effect of carbon dioxide or plant growth has been variously demonstrated. Stocklasa obtained an increase in weight from 52.6 g., the weight of the ungassed plant, to 142.4 g. the weight of the plant gassed with carbon dioxide. That certain substances as aluminum may interfere with root growth has been demcnstrated with barley, that sublimate even in smallest quantities is toxic, has been demonstrated with geranium plants.



a

b c

d

Fig. 7. Elements of Nutrition and Poisoning.

a. Geranium; Mineral Nutrient to Which the Following Quantities of Bichloride of Mercury Have Been Added. Left to Right, .00005 Per Cent.; .0001 Per Cent.; .0005 Per Cent.; .001 Per Cent.; .003 Per Cent.; .005 Per Cent.; .007 Per Cent.; .009 Per Cent. (After Zander.)

b. Corn, Small Plant With Normal Carbon Dioxide. Large Plant With Excess Carbon Dioxide. (After Stocklasa.)

c. Barley, Left, Without Aluminum. Right, With Aluminum.

d. Maize, Showing Effect of Chemicals on Growth. Left to Right. Mineral Nutrient Solution, Distilled Water, Without Potassium, Without Phosphorus, Without Iron, Check on No. 1. (After Zander.)

Soils consisting of 50 per cent. more of sand generally are regarded as "light," and as especially adapted to the raising of early vegetables. Soils containing more clay and less sand constitute the "medium" or "heavy" classes. They have been found best suited either to corn, potatoes, tobacco, cotton, and fruit—or to grass and other dairy-farming crops.

Even though soils may be similar in mechanical composition,

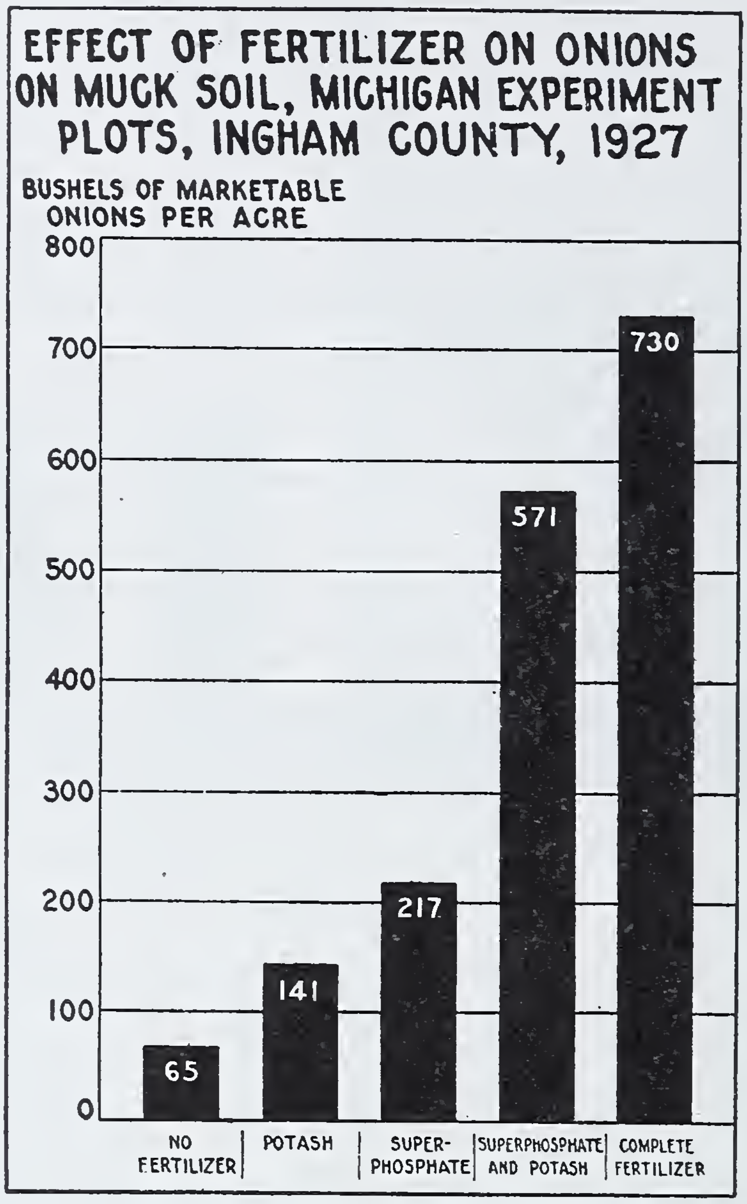


Fig. 8.

certain factors as climate or drainage may alter their adaptability to the same crops. Cotton, for instance, is restricted to the climate of the Southern States; it may be grown there readily on various types of soil except those of very deep sand or very hard clay.

When well drained and rolled, the muck and neutral fertilized peat soils are excellent soils for celery, cabbage, onions, sugar beets, all kinds of truck crops as potatoes, for hemp—peppermint, spearmint and grasses. Professor Harmer's interesting results are given below.

Onion Yield on Fertilized Peat Soils

Fertilizer applied broadcast 1922-23-24-25-26-27, and pounds per acre	Marketable onions bush. per acre	av. wt. per onion ounces	% of immature onions	% of bulbs sprouted May 15
No fertilizer	65	12	82	36.4
Muriate of potash, 500 pounds	141	1.7	72	15.2
Superphosphate, 750 pounds	217	1.5	32	51.0
Phosphate, 750 pounds; potash 500 pounds	571	2.6	12	11.5
Nitrogen, 300 pounds; superphosphate, 750 pounds, and potash, 500 pounds (balanced fertilizer)	730	3.3	7	13.4

Most of our vegetables, beets, cabbages, squash, tomato and pumpkin, lettuce, and celery—the bean, wheat, rye, and corn grow satisfactorily on circumneutral soil—while the potato evidently prefers subacid soils.

These data check well with the lime requirements as determined by the soil workers of the Wisconsin Agricultural Experiment Station. Sugar beets, cabbage, lettuce, onion, spinach have a very high lime need, peas, cauliflower, barley a high—peanuts, corn, potato, turnip, carrot, radish and grape a medium, sweet potato a low lime need.

SOIL REACTION IN HYDROGEN ION CONCENTRATION. (pH)

ACID—(SOUR)			CIRCUM—(NEUTRAL)			ALKALINE—(SWEET)		
3.1—4.0	4.1—5.0	5.1—6.0	6.1—6.9	7.0	7.1—7.9	8.0—8.9	9.0—9.9	10.0—10.9
Super Acid	Medi Acid	Sub Acid	Minim Acid	Neutral	Minim Alkaline	Sub Alkaline	Medi Alkaline	Super Alkaline

SOIL REACTION SCALE

DRUG PLANTS Digitalis purpurea (fox glove) and the plant yielding one of the most important drugs, a heart stimulant, as well as Sarothamnus scoparius (broom bush), do evidently not thrive well on calcareous or alkaline soil (see Ill.). Digitalis grew and fruited under the most favorable circumstances in soil containing 6 per cent. lime, though plants showed weakened condition. Grown on clay and lime soil the plants died after two months. In soil with 32 per cent. lime the plants grew only to four-fifths of an inch.

Tobacco, according to soil workers of the Wisconsin Experiment Station, requires a very high lime content, hops, rape, mulberry require a high, rhubarb and hemp a medium, flax a very low amount of lime for satisfactory growth.

In his studies of soil reactions preferred by the "snake roots" obtained from the drug plant Polygala Senega (a cough relief) and

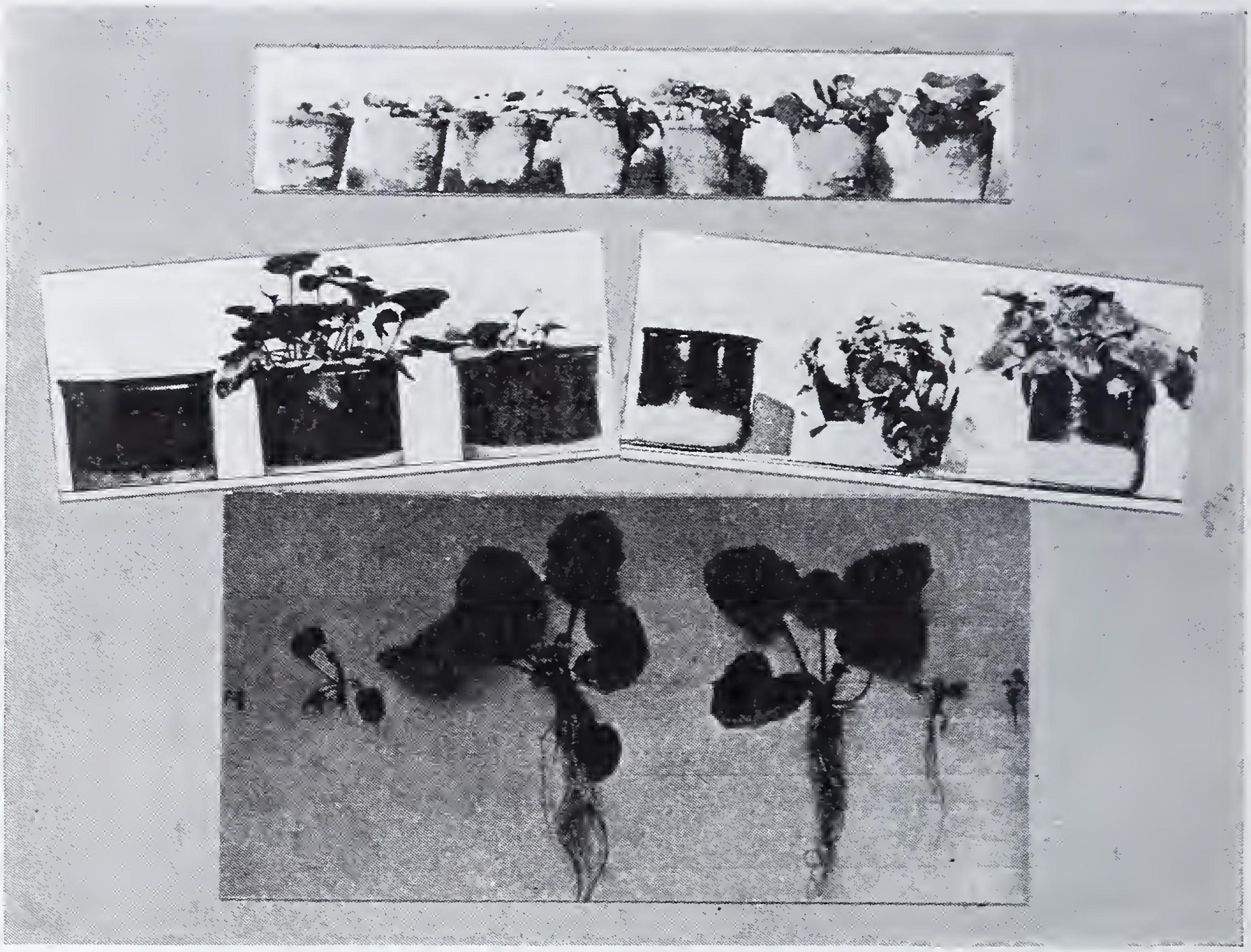


Fig. 9. Coltsfoot. (Tussilago Farfara.)
a. Influence of Soil Reaction. Ph. 3.6; 4.7; 5.2; 5.4; 6.7; 7.6; 7.7.
b. Nitrogen Availability. NH_4Cl NH_4NO_3 NaNO, After 1½ Months.
c. Nitrogen Availability. NH_4Cl NH_4NO_3 NaNO, After 3½ Months.
d. In Nutrient Solution. 3.5; 4.5; 5.5; 6.5; 7.5; 8.0. (After Olsen.)

related species, Wherry found variation from minim-alkaline dry soil (ph 7.1-7.9) to mediacid wet soil (ph 4.1-5.0) and all intermediate degrees. Polygala Senega tested in Virginia and Pennsylvania, the variety latifolia in Arkansas, the species alba, known as false senega, tested in Texas and Oklahoma, all preferred minim acid dry soil (ph 6.1-6.9).

Experiments with coltsfoot, grown under varied conditions in soil and nutrient solution, proved the marked influence of hydrogenion concentration and source of nitrogen, affecting this concentration, upon growth (see Fig. 9).

Drug and Poisonous Plants*

Plants Apparently Preferring Mediacid Soils (ph 4.1-5.0)

Arnica	Arnica.
Coptis trifolia	Goldthread.
Cypripedium acaule	Pink Ladyslipper.
Drosera	Sundew.
Epigaea repens	Trailing-arbutus.
Ilex opaca	American holly.
Kalmia polifolia	Bog Kalmia.
Ledum groenlandicum	True Labrador-tea.
Magnolia glauca	Sweetbay.
Sorbus americana	American Mountain-ash.

Plants Apparently Preferring Subacid Soils (ph 5.1-6.0)

Acer spicatum	Mountain Maple.
Aletris farinosa	Star grass.
Anaphalis margaritacea	Pearl Everlasting.
Arachis hypogaea	Peanut.
Athyrium filixfemina (angustum)	Upland Lady Fern.
Baptisia tinctoria	Yellow Wild-indigo.
Betula lenta	Sweet Birch.
Castanea dentata	American Chestnut.
Castanea pumila	Chinquapin.
Ceanothus americanus	Jersey-tea.
Chamaecyparis, named species and varieties	Cypress.
Chamaelirium luteum	Fairywand.
Chionanthus virginica	White Fringetree.
Cimicifuga americana	American Bugbane.
Clematis crispa	Curly Clematis.
Comptonia asplenifolia	Sweetfern.
Convallaria majalis	Lily-of-the-valley.
Cunila mariana	Stonemint.
Cystisus scoparius	Scotch Broom.
Daphne, named species (D. odora and D. Mezerum) minimalkaline	Daphne.
Dryopteris dilatata (americana)	Mountain Woodfern.
Eryngium aquaticum	Button-snakeroot.
Gaultheria procumbens	Wintergreen.
Gelsemium sempervirens	Carolina-jessamine.
Heuchera villosa	Hairy Alumroot.
Ilex cassine	Dahoon.
Ilex opaca	American Holly.

*Selected from Dr. Wherry's findings.

Iris carolina	Southern Blueflag Iris.
Juniperus communis montana	Mountain Juniper.
Kalmia angustifolia	Lambkill.
Kalmia latifolia	Mountain Laurel.
Lycopodium clavatum	Runningpine.
Magnolia (accuminata, tripetala, excepting M. glauca)	Magnolia.
Menyanthes trifoliata	Common Bogbean.
Mitchella repens	Partridgeberry.
Myrica	Bayberry.
Nicotina species (also listed under circumneutral)	Tobacco.
Oxalis acetosella (montana)	Common Woodsorrel.
Phlox ovata	Mountain Phlox.
Pinus, many though not all species	Pine.
Polygala paucifolia	Fringed Polygala.
Rhododendron	Rhododendron.
Rubus idaeus	European Raspberry.
Solanum tuberosum	Potato.
Spiraea tomentosa	Hardhack.
Ulex europaeus	Common Gorse.
Viola pedata	Birdsfoot Violet.
Zygadenus	Poison lily.

Plants Apparently Preferring Minimacid Soils
(ph 6.1-7.0)

Aesculus pavia	Red Buckeye.
Amelanchier	Shadblow.
Apocynum androsaemifolium	Spreading Dogbane.
Avena sativa	Oats.
Cardamine pratensis	Cuckooflower.
Citrullus vulgaris	Watermelon.
Corylys rostrata	Beaked Hazelnut.
Epilobium angustifolium	Blooming Sally.
Garcinia mangostana	Mangosteen.
Gillenia trifoliata	Bowmansroot.
Hicoria ovata	Shagbark hickory.
Juniperus communis and var.	Common juniper.
Juniperus Sabina and var.	Savin juniper.
Juniperus Virginiana	Red Cedar.
Linum usitatissimum	Flax.
Liquidambar styraciflua	Sweetgum tree.
Liriodendron tulipifera	Tulip tree.
Lupinus hirsutus	European Blue Lupine.
Monarda didyma	Oswego Beebalm.
Ostrya Virginiana	Am. Hophornbeam.
Phaseolus lunatus	Lima Bean.
Quercus velutina	Black Oak.

Rubus occidentalis .... Common Blackcap.
Sassafras variifolium .... Sassafras.
Sophora japonica .... Japanese pagoda tree.

Plants Apparently Preferring Circumneutral Soils (ph 6.1-7.9)

Acacia .... Acacia.
Aconitum .... Monkshood.
Adiantum .... Maidenhair Fern.
Aesculus .... Buckeye.
Ailanthus, named species .... Ailanthus.
Allium porum .... Leek.
Alnus .... Alder.
Althea species .... Hollyhock.
Apium graveolens .... Celery.
Asparagus .... Asparagus.
Aquilegia, many species .... Columbine.
Aralia, many species .... Aralia.
Artemisia .... Wormwood.
Aster, many species .... Aster.
Berberis .... Barberry.
Beta, vulgaris varieties .... Beet.
Calendula officinalis .... Calendula.
Catalpa species .... Catalpa.
Celastrus .... Bittersweet.
Centaurea species .... Centaurea.
Cephalanthus occidentalis .... Buttonwood.
Cercis .... Redbud.
Clematis .... Clematis.
Crocus .... Crocus.
Cydonia .... Flowering quince.
Delphinium, many species .... Larkspur.
Dianthus .... Carnation, Pink.
Digitalis .... Foxglove.
Dirca palustris .... Leatherwood.
Erythronium .... Trout Lily.
Eucalyptus species .... Eucalyptus.
Gardenia species .... Cape Jasmine.
Gentiana .... Gentian.
Geranium .... Cranesbill.
Gymnocladus dioica .... Kentucky Coffee Tree.
Hamamelis Virginiana .... Witch-hazel.
Hedera .... Ivy.
Helianthus .... Sunflower.
Hordeum vulgare .... Barley.
Hypericum .... St. Johnswort.
Impatiens .... Impatiens.

Ipomea	Morning glory.
Juglans	Walnut.
Lactuca sativa	Garden Lettuce.
Ligustrum	Privet.
Lonicera	Honeysuckle.
Lobelia, many species	Lobelia.
Lycium, many species	Matrimony vine.
Mentha, many species	Mint.
Narcissus	Narcissus.
Oenothera	Evening primrose.
Origanum species	Majorum.
Oxalis	Oxalis.
Paeonia	Peony.
Panax Quinquifolium	American ginseng.
Passiflora	Passion flower.
Phylittis scolopendrium	Hartstongue.
Polyganatum species	Solomon's seal.
Populus	Poplar.
Potentilla, many species	Cinquefoil.
Piper	Pepper.
Quercus alba	White oak.
Radicula armoria	Horse radish.
Raphanus sativas	Radishes.
Reseda	Mignonette.
Ribes	Currant, Gooseberry.
Robinia, named species	Locust.
Rosa	Rose.
Salix	Coneflower.
Sanguinaria canadensis	Bloodroot.
Scilla species	Squills.
Secale cereale	Rye.
Sempervivum, many species	Houseleek.
Sheperdia argentia	Silver buffaloberry.
Solanum dulcimara	Bitter nightshade.
Solanum, many species	Nightshade.
Solidago, many species	Goldenrod.
Sorbus aucuparia	European Mountain ash.
Spiraea (many species)	Spirea.
Syringa	Lilac.
Tamarix, named species	Tamarix.
Taraxicum officinale	Dandelion.
Taxus	Yew.
Tulipa	Tulip.
Tussilaga farfara	Coltsfoot.
Vinca, named species and varieties	Creeping myrtle.
Viola (many species)	Violet, pansy.
Xanthoxyllum americanum	Prickly ash.

5. TOUGH TURFS Turfs are the foundation of golf links, parks and home grounds. They must be resistant to wear and abuse, and special attention must therefore be given to the preparation, grading, cultivation and enriching of the soil, to the selection of good seed or grass-stolons, and to continued care. A deep loamy soil, already possessing a good texture, needs but to be enriched with plant food elements. A stiff clay soil to produce a good turf must be mixed with both sand and vegetable matter. Clay will improve light sandy soils. "Decayed vegetable matter, or humus," state the U. S. soil experts, "lightens the texture of clay soils, increases their water holding capacity, and improves their drainage; it also improves sandy soils by making them more cohesive and more retentive of moisture." The top soil, carefully leveled, should be made loose and fine for a depth of 2 to 3 inches.

Drainage, if necessary with tiles, must be provided, as it is recognized that "perfect turf cannot exist without perfect drainage." Neither can good turf be maintained in our climate without an artificial supply of water. Enough water should be used to wet the ground down at least 4 to 6 inches at a time to reach the deeper grass roots. Continuous watering, however, washes the plant food from the soil and starves the turf.

Bone meal, best applied in late winter or very early spring at the rate of 10 pounds to 1000 square feet, is referred to as one of the best commercial fertilizers by U. S. soil experts. They also recommend the application, three times a year, of a mixture of one part of ammonium sulphate and three parts of organic plant food as cotton seed meal, applied at the rate of 12 to 15 pounds per 1000 square feet. Annual whitewashing of turfs with lime is now known to be both wasteful and detrimental as it encourages greatly the growth of certain weeds and clover. It is believed that 50 pounds hydrated lime (lawn lime) applied to 1000 square feet once in six to eight years will be sufficient for any soil type.

The best insurance against weeds is the dense stand and vigorous growth of the cultivated grasses, which will give crabgrass and other weeds, as dandelion, plaintain, chickweed, veronica and oxeye daisy little opportunity to grow. The top dressings must be free of weed seed. The soil reaction is preferably kept acid (to prevent weeds as chickweed) unless white clover, requiring a limed soil, is grown. This, mixed in grass mixture, is used for an even and especially for a sloping lawn.

While ammonium sulphate alone will eliminate weeds from the acid resistant bent and fescue grasses, a mixture with acid phosphate and potassium muriate in amounts of 250 pounds each per acre will furnish a more complete plant food. This is recommended by soil workers of the Rhode Island State College. The weeds will be gradually crowded out, especially if the acid reaction of the soil is maintained by annual or more frequent application.

Turf Grasses

1. *Kentucky Blue Grass*—Poa pretensis

A native of the Old World, it is now a favorite grass for fairways and lawns, in the North, and is also the principal pasture grass on all rich soils. It is a perennial, creeping underground, having very narrow, vivid, deep, green leaf blades. It grows abundantly on all good soils, whether rich in lime or poor.

2. *Sheep's Fescue*—Festuca ovina

This is an excellent grass for fairways and lawns to grow on poor, sandy or gravelly land and a valuable element of pastures on such soils. It is mixed with other grasses to make a durable sward. A bunch grass with dense tufts and wirelike, bluish gray leaves.

3. *Red Top*—Agrostis alba or palustris

As a vigorous grower, forming a coarse, loose turf, it is considered valuable for fairways and lawns if mixed with other grasses as blue grass. It is a perennial grass with creeping growth and narrow leafblades. It is strongly drought resistant, protects banks against erosion—grows on soil very poor in lime, but will not last more than a year or two under lawn conditions.

4. (Shady Lawn Grasses)—Red Fescue—Festuca rubra (Chewing Fescue)

This is much used grass for golf courses, where the soil is sandy, and for steady lawns, as it will withstand more shade than most grasses. It has bright green leaves and creeps by underground stems.

5. *Birdgrass*—Poa trivialis

"The queen of the pasture grasses" is far superior to any other grass on shady lawns. It is best adapted to cool moist soils. It spreads by stolons or creeping branches on the surface of the ground. The

leaves are apple green, remain bright green in winter weather. The turf makes an exquisite lawn.

6. *Southern Turf Grasses.* Bermuda grass—Cynodon dactylon

This is the most important plant for pastures and lawns in the South, particularly on clays and loams though it grows more or less abundantly on sandy soils. It occurs in varied forms with pale green to rich blue green foliage and is commonly planted by stolons.

7. *Italian Rye Grass*—Lolium italicum

The seed sown on Bermuda grass, turning brown in the fall, makes a bright green winter sward and excellent fairway for winter. It is treated as an annual, produces a turf very quickly and is used as a temporary pasture.

8. *Putting Green Grasses*—Creeping Bent—Agrostis Stolonifera.

It is in great demand for golf courses, as it is considered one of the finest grasses for putting greens, producing a beautiful fine turf. It has creeping stolons or runners, which grow as much as 4 feet long in a season. There are many strains, bluish to green, and coarse to very fine. The grass grows well, especially in seaside meadows and on light moist soil.

9. *Rhode Island Bent*—Agrostis tenuis

It yields a beautiful grass, making a fine turf, also used for putting greens. The seed forms usually a large proportion of the highly esteemed South German mixed bent. It has narrow flat leafblades, forming dark green turf and succeeds well on well-drained soils, including acid soils—liming in fact injuring the turf.

6. BUSH AND BLOOM

Broad-leaved Evergreens.—One of the most decorative blooming bushes, grown more and more frequently in our parks and gardens—is the Rhododendron. Our domestic production of these plants, recently stated a representative of one of the largest nursery dealers, only dates back to about 1915. It has been carried on principally by men who acquired their training in Holland where the natural soil conditions are such as to produce an abundance of growth. No artificial means of fertilizing are necessary there, or any other preparation, with the exception of attention to such details as planting at the proper time, and clean culture. Mainly through the lack of scientific knowledge of funda-

mental soil requirements there have been many losses and disappointments in our attempt to produce these plants on a large scale.

It is now definitely known that mycorrhiza (fungi) live in close association with the roots, and most of these favor acid reaction of the soil. Where the soil is normally acid, the addition of leafmold, cow manure, acid peat or peat moss and good fibrous loam have given good results, provided no lime was present to neutralize the acid in the soil. Cuttings have been rooted in sandy acid peat or peatmoss litter with sand, young plants transplanted with good balls of soil around roots have been grown successfully in limefree loam or sandy peat, enriched with humus or well-decayed vegetable matter, rotting wood, half-rotten oak leaves, spent tan barks, rotted sawdust from non-resinous woods. Aluminum sulphate applied in amounts of about 1 pound to 18 square feet of ordinary garden soil has been found to produce satisfactory acidity and growth.

For continued growth the adoption of soil conditions where rhododendron grows wild has been found desirable. The soil there is acid and of loamy nature, rich in mineral plant food, well drained, though retentive of moisture. The acid top layer is full of partly decayed organic matter, in which the shallow-rooted plants feed. Addition of organic matter to the soil at the time of planting and successive mulching retain the water, needed even in winter, and prevent deep freezing.

Other broad-leaved evergreens as azaleas and mountain laurel (kalmia latifolia) thrive under similar conditions of acid soil. The same is true of trailing arbutus, heath, heather, huckleberry, bearberry, cranberry, wintergreen and andromeda.

Of interest in this connection is that certain strains or related species of these acid soil loving bushes, may be found thriving on lime soil. Such is the case with certain Chinese species of rhododendron, found on lime cliffs and grown for seven years in limed soil.

Hydrangeas (the Red, White and Blue).—Of other interesting and highly ornamental plants the hydrangeas are highly favored. They thrive in any good, well-drained, but somewhat moist garden soil, preferring a rich porous soil mixture. Three principal types are grown, the somewhat tender shiny leaf hydrangea also called garden or Japanese hydrangea; the shrubby and the climbing hydrangea. While these latter have predominantly white colored flowers, the flowers of the shiny leaf hydrangeas occur in varied colors, dependent evidently on the soil reaction. Lime in some excess produces pink

flowers, in great excess a yellowing and a stunting of growth. Acid conditions, use of alum, rusty iron, iron filings, cause a blue coloring. The treatment, according to the U. S. Horticulturist, E. L. Mulford, must be started one year before the result is desired. In young potted plants this blueing of flowers may be obtained upon watering with an alum solution (one tablespoon to a gallon). In a bush several tinned iron can covers planted two inches from the plant and four inches deep in the soil produced a remarkably deep blue hue.

While the magnolias generally prefer subacid soil, our common decorative bushes: forsythia, hawthorn, lilac, deutzia, the butterfly bush, rosemallow, mockorange and the spireas; our hedges: common box, barberry and privets; our climbers: ivy, grapevines, honeysuckle, clematis, euonymus, convolvulus, wisteria, all do well on circumneutral soil. Wisteria requires a special dose of potash, water, wants sun, except the South Atlantic variety growing and blooming in the shade.

Fruit Blooms, Bulbs and Cut Flowers

Pear, cherry, plum and apple, currant and gooseberry, almond and peach grow satisfactorily on circumneutral soil; so do the bulbs of spring: the hyacinth, tulip, and narcissus; the bulbs of summer: gladiolus, peony and dahlia. while woodland lilies prefer subacid soil. All bulbs are said to like a cool, moist, well-drained soil, shade for the bulbs and lower part of stems, plenty of light and air above.

Phlox species want subacid soils, some iris species as the Japanese and Oregon iris the same—other flags and most delphinium species prefer a circumneutral soil. So do sweet peas, grown best in black, heavy, fertile soil with lots of water.

Recent researches (reported at the New York Meeting of the Association for the Advancement of Science) show that flowering plants grown under controlled conditions in silt lawn soil of medium organic content in a greenhouse, yielded the following suggestive results:

Snapdragons gave the most flowers in an acid soil (ph of 6.0 to 6.5); in an alkaline soil, the best stems (ph of 7.0 and 7.5).

Calendula gave the best flower and stem in an alkaline soil (ph 8.0). The root development was very poor in very acid plots. Carnations developed most flowers in an acid soil of (ph 6.5). Chrysanthemums gave largest flowers and best stems in slightly acid soil. Cyclamen preferred acid soil (ph 5.0 to 6.0). Primula malacoides was

very sensitive to acid soil, dying in a soil of ph 5.0 within two weeks. Primula obconica, geraniums, callas and cinerarias showed a preference for alkaline soil. The only flowering plant evidently growing well in all ranges of soil reaction was coleus.

Orchids, as far as known and grown in soil, prefer the acid reaction. The cultivation, difficult though it is, has greatly increased, on account of the exquisite beauty and remarkable keeping qualities of the flowers. Cut flowers of some orchid species have remained perfect for more than three weeks, flowers left on the plants have kept perfect for more than three months.

The greatest obstacle in the growing is the germination of the seed, which, lacking food for its own germination, requires the presence and nursing help of certain specific forms of micro life, fungi, or the nourishment with a specially balanced, sterile nutrient agar.

ROSES—Sappho, so many years ago already, concluded:

"The rose, mankind will all agree,
The rose the queen of flowers shall be;
Its fragrance charms the gods above,
Its beauty is the food of love."

We can scarcely conceive of a garden void of roses. The rose included somewhere in the friendly lawn, framing the home, greatly enriches its ornamental value. However, the ground is often poorly prepared or unsuited. Either the soil lacks certain valuable ingredients or is rose fatigued, through prolonged growing of roses. Even the neglect of providing a mound of soil around the pruned branches of newly planted roses, handicaps the rose from the start. Destructive soil life, as worms and bugs in greenhouse soil, may be kept down by partial sterilization of the soil, or by cut potatoes placed near the base to attract the worms.

Roses in general prefer a cool, loose, fairly heavy, fertile, circumneutral loam soil containing sufficient humus, lime as well as some magnesium.

Lawn soil prepared to 20 and 25 inches depth with an application of one-half pound of chalk to the square yard of rose bed area, well supplied with humus and complete fertilizer and in early spring with an ounce of magnesium sulphate to the same area is said to have given continued good results.

Washington, the heart of the Nation, is also the show place for bush and bloom, for lawn and park, and experimental growth. Great gardens as the DuPont gardens and greenhouses near Wilmington, or the famed Magnolia, Azalea and Middleton gardens of Charleston, South Carolina, the rose gardens of Portland, Oregon, and Pasadena, California, enriched by the blend of natural beauty and human skill in selection and care, are rapidly becoming national institutions. In many other communities we find now magnificent gardens, parks and reservations.

There is a growing public demand for state or nationally owned and surveyed parks, creek, lake, river shores and forests. Thus much

Fig. 10. Man's Control of Nature's Carpet.
U. S. Agricultural Department Grounds, Washington, D. C.

destruction by the element of nature or by man of soil or sod is prevented. Natural wonders are preserved or re-created as lasting contributions to American life.

Results and Outlook

1. Though skill has grown, though many a long-hidden secret is now disclosed, no certain mastery of soil and sod as yet has been achieved.
2. When sand or clay, or stone predominate, the proper blend of soil ingredients does not prevail—humus is needed too.
3. The spirit of the soil is dead, whenever micro life is made to die through lack of water, air and worthy elements of food.

4. Fair climate, fertile soil and well-adapted crops should make the growing possible, though parasites of molds and bugs play frequent havoc yet with root or fruit with leaf or stem.
5. The proper care of soil as well as sod, an all-important task, will help to grow God's plants this year and next and untold years to come.
6. Men must assume control, though here and there in ignorance of what to do; quick action, wisely used, will often save his starving grounds at home, the soil and suffering crops afield, restore, assure the fertile beauty of a magic force.

Thus with man's help we see how life prevails victorious over death—from barren waste of rocks over the sterile sand of deserts—through the green hell of the jungle to the heavenly fertile fields and man's throne, the home, midst verdant carpets and the splendor of gorgeous blooms.

"With eager eye and earnest face
The Man of science long pursues
The quest—succeeding, then renews
His zealous search with quickened pace."

(*C. A. Ruckwick*)

TIME—WHAT KEEPS IT?

By George Rosengarten

WE CANNOT TURN BACK the hands of time; we may plan for the future but the past is forever closed. Time proceeds in one direction with absolute uniformity.


George Rosengarten

"What time is it?" you have been asked and you consulted your watch and gave an immediate answer; but suppose the questioner should ask, "How do you know what time it is?" could you answer just as quickly? The year 1929 is the 300th anniversary of the birth of Christian Huygens and it is fitting that we should consider the question of Time. What keeps It? He was a man of varied scientific attainments, who realizing the importance of an accurate timekeeper gave to the world the pendulum clock.

Modern civilization depends upon your knowledge of correct time. You rise at a predetermined time and breakfast, leave your home to catch the 8.15, arrive at the office in time to meet the engagements you have made. You consult your watch and you expect an interview. 'Tis dinner time and you knew it. We all have a hunger sense even though some of us lack a time sense. Imagine if you can the confusion in your daily program if correct time were unknown.

I shall ask you to go back in thought, before the days of our so-called civilization, somewhat nearer the beginning of time. After geologic ages had passed and the earth had cooled a bit, our ancestors began their existence. Watch this semi-barbarian as he observes the splendor of a sunrise and then follows that shining globe across the sky to observe it again to sink below the horizon, leaving him in darkness to wonder whether it would ever rise again. What a train of thought must have been started. He had discovered time; the succession of events which the mind perceives to follow one after the other without interruption. If you did not sense a change within or without yourself you would not possess the sense of time. The instant of the present is preceded by all that is past and in the words of Roger Bacon,

"Time is, Time was." Day follows night, summer follows winter, old age follows youth.

How then can we measure the passage of time. The sun by day and the stars by night undoubtedly supplied man with his first timepiece. In order to measure time it is necessary to have a phenomenon which repeats itself at regular intervals. The apparent rotation of the heavens caused by the rotation of the earth is the phenomenon upon which all time recording devices must ultimately depend. Our early ancestors allowed the imagination full play and in the stars perceived the forms known as the signs of the Zodiac or as the Germans call it, the Thierkreis, which translated means the animal circle, since many of these imaginary forms resembled animals. The time of planting or the time of harvesting in which they were most interested was determined by the rising or the setting of a particular Sign or Constellation. Man had little use for a timepiece which indicated minutes and seconds. The interval between sunrise and sunset gave him a natural unit, the day, which however was longer in the summer and shorter in the winter.

You have noticed the changing length of your shadow throughout the day being longest in the morning and evening and shortest at the midday. This phenomenon enabled man to divide the daylight into two equal parts since the instant at which the shadow is shortest divides the interval between sunrise and sunset equally. Later the daylight was divided into twelve hours and the darkness into twelve hours which varied in length with the season. At the time of the winter solstice the hours of the daylight were about forty-four minutes long while those of the darkness ran as high as seventy-five minutes. These conditions were reversed at the summer solstice. Modern civilization with all of its improvements in electric lighting has eliminated the necessity for these short hours during the winter months.

To indicate the time of day the sundial was invented. In order that the shadow cast by the style show the time, it must be directed toward the North Pole of the heavens and thus makes an angle with the horizontal equal to the latitude of the place. At the poles of the earth we use a vertical style and at the equator it would become horizontal.

These dials were dependent upon the light of the sun and to overcome this difficulty we find several kinds of water clocks or clepsydra came into use. The simplest form of water clock was a dish with a small hole in the bottom which allowed the water to run out

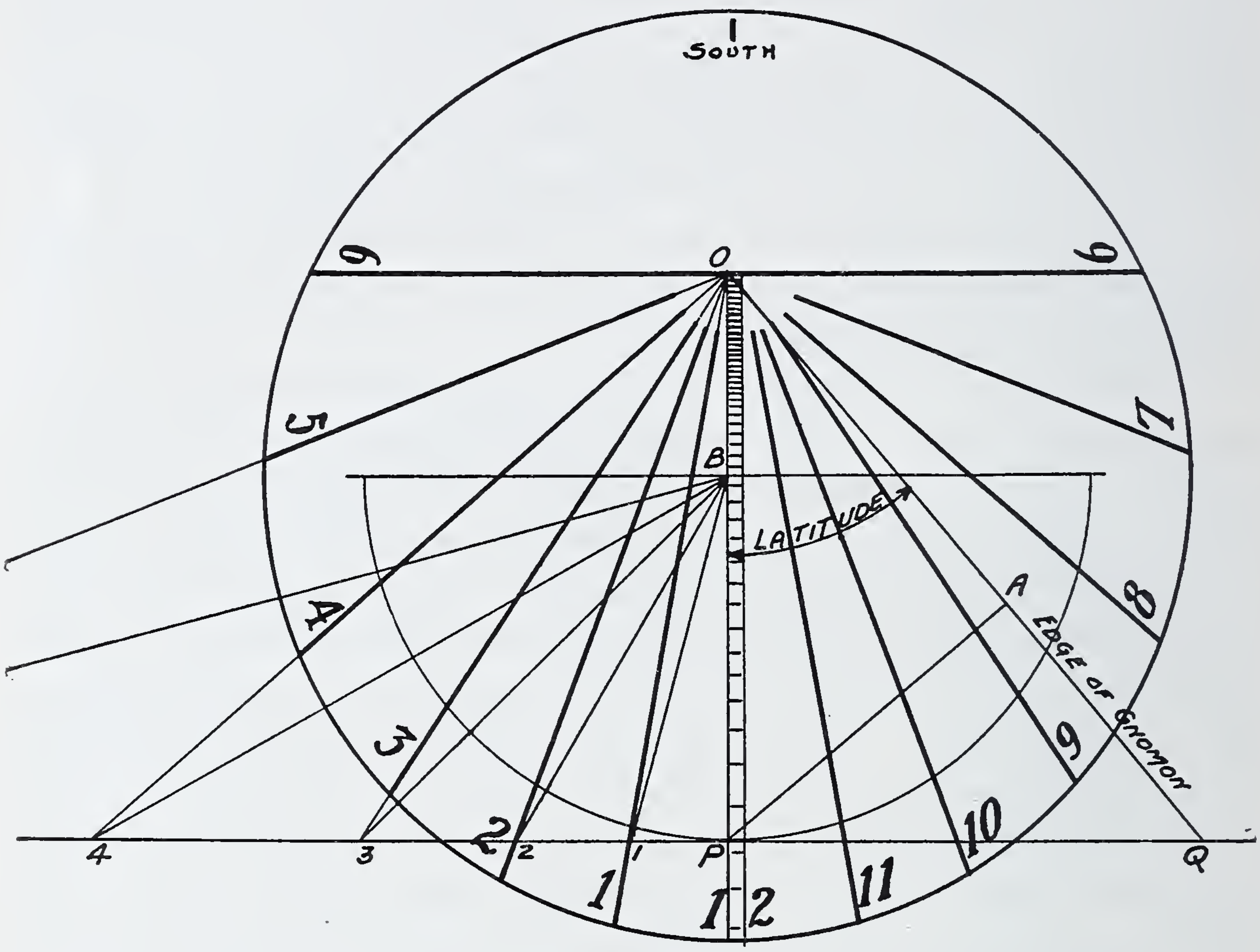
slowly and thereby indicate a definite period of time. Of course such a clock required the attention of an attendant who would strike a bell as the dish emptied and refill it again. Such water clocks were used in Rome and many a Senator was called upon to cease his discourse at the sound of the bell. A similar device employing sand persists in some of our kitchenettes. Many of the old sand glasses would require an hour for the sand to flow from the upper bowl into the lower bowl. When it runs down you must turn it over, a difficulty which still exists with the calendar about which I shall speak later. We have ceased to use the sand glass as a measure of time, but we continue to use the old calendar. It is told of an old divine after addressing his congregation for an hour with his thirdly and fourthly, seized the sand glass in his hand, turned it completely around and said, "Brethren, let us take another glass," and so continued for another hour.

It was not until about 1300 A. D. that mechanical clocks were invented. With this introduction we shall examine in more detail the question of time-keeping.

The edge of a building or a vertical pole may serve as an indicator of the time of noon. By drawing a circle with the foot of the pole as a center and observing the points on the circle at which the end of the shadow crosses before and after noon we can determine the position of the shadow at midday by dividing the distance between these two points on the circle into two equal parts and placing there a marker. Each day as the shadow falls upon the mark it is an indication of the time of midday. The sundial which sometimes adorns the garden or is placed upon the side of a building gives a much better indicator of the passage of time. Many and peculiar have been the devices used to cast the shadow. Sometimes the shadow of a cross or a large sphere is used as a gnomon which is the name given to that part of the sundial which casts the shadow. In the book of Isaiah, chapter 38, verse 8, we find Isaiah saying, "Behold I will bring again the shadow of the degrees which is gone down in the sundial of Ahaz, ten degrees backward." The meaning is not clear but we have this definite record of use of a sundial from about the eighth century B. C.

THE SUNDIAL The sundial in its most usual form consists of an upright piece whose edge is directed toward the North Pole of the heavens and the shadow cast thereby falling upon a horizontal dial which has been marked with the hours. It is not a difficult piece of work to construct such a sundial and you will be well repaid

for the attempt; an ornament for your garden and an indicator of the time of day. The materials to be used may be either wood or metal, the latter being more permanent since the dial must be placed out of doors in order that it may cast a shadow. With a good protractor layout from O (see diagram) a line making an angle with the vertical equal to the latitude of the place where the dial is to be used. The triangle OPQ will give the shape of the gnomon or the shadow casting part of the sundial which is to be fastened in a vertical position with the side OP in contact with the horizontal dial. Since the shape of



SUN DIAL

the triangle depends upon the latitude it will be observed that a sundial that will indicate time for a certain place will be unsatisfactory if moved to a place further north or south. To lay out the dial we first draw a line PA perpendicular to the edge OQ and with B as a center swing the arc AP. The line BP is now made the radius of a reference circle whose semi-circumference is to be divided into twelve equal parts. From the point B extend lines through these points on the circle until they intersect the line PQ extended at the points 1, 2, 3, etc. To complete the left half of the dial it is only necessary to con-

nect the point 1, 2, 3, etc., with the point O. Since the gnomon will have some thickness, represented by the shaded portion of the figure, the right hand part of the dial which is similar in construction to the left, must be displaced by an amount equal to the thickness of the gnomon.

When the gnomon has been securely fastened to the dial it is ready to be placed in the garden. A stone or brick pier may be constructed to receive the dial. On a clear starlight night place the dial upon the pedestal and turn it around until the inclined edge of the gnomon points to the north star of the heavens. A board with parallel edges placed upon the inclined gnomon will allow you to sight along the upper edge and secure a better alignment. Once set, the dial should be made secure so as not to be disturbed. From sunrise to sunset this dial will indicate the passage of time to all who will stop and watch its slowly moving shadow.

The time from one indication of the midday to the next is called a Solar Day, and it is found to vary slightly in length throughout the year. The earth in its journey around the sun does not move with constant speed. At the time of perihelion when the earth is nearest the sun it travels fastest, while at the aphelion its motion is slower. The axis of the earth is inclined to the path which the earth follows through space. It is the combination of these two conditions which cause the Solar days to vary by as much as sixteen minutes more or less from the mean time as recorded by your watch. The mean Solar time is the time that would be recorded on a sundial by a fictitious sun which moved uniformly throughout the year along the celestial equator. The shadow cast by such a sun would indicate the hours in accordance with a well-regulated watch. But since the shadow cast by a sun that does not exist cannot be observed, how shall we determine the time.

THE EQUATION OF TIME

The equation of time is the difference between the apparent Solar time and the Mean Solar time. This indicates the number of minutes to be added or subtracted from the time as registered by the sundial in order to make it agree with the Mean Solar time which you keep on your watch. The American Ephemeris and Nautical Almanac for 1929 states that the Mean Solar time agrees with the time as given on the sundial on four days during the year, April 15, June 15, September 1 and December 25. On all other dates a correction differing in amount must be applied to the reading of the dial (see Fig. 2).

Perhaps you ask the question, "How do you know what time is?" or "Which time is correct?" I may reply by another question and ask, "What is time?" but this is unfair and does not answer your question. Since our concept of time is something that must progress with absolute uniformity, the fact that the time as recorded on the sundial varies from day to day must of necessity eliminate it as a standard for the determination of time.

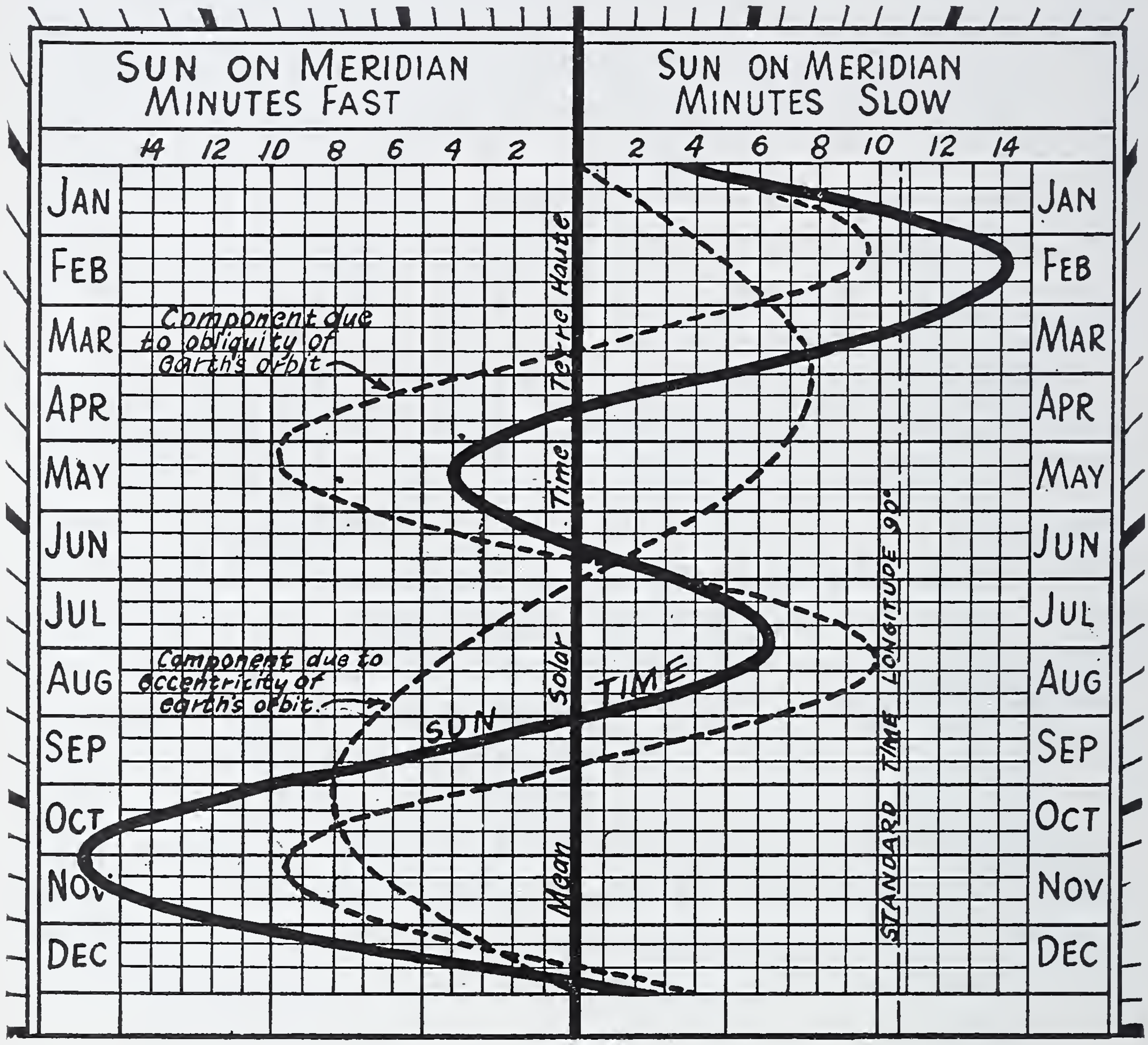


Fig. 2.

Graph showing correction to be made to time as indicated by Sun Dial.

The only physical phenomenon which possesses anything like the regularity which is demanded by our concept of time is the apparent revolution of the heavens. There is a point in the northern sky, not far from the north star Polaris, around which the stars appear to rotate in a counter-clockwise direction. It is the earth and not the stars that are turning, as was demonstrated by the Foucoult pendulum experiment. (See *Popular Science Lectures,* Vol. VI, p. 151). The time for one complete rotation of the stars about the pole is called a

Sidereal Day and is constant to within 1/200 second. As a means of reference the vernal equinox was chosen as the point in the heavens which would determine by its passage over the meridian the moment at which your local sidereal day would begin. I have used the term local time since as you must know the time is intimately related to the position on the earth. When it is 7 A. M. in Philadelphia, it is 12 noon in London.

In order that we may be supplied with the correct time the astronomer must determine with extreme care the instant that one of the circum-polar stars crosses the meridian. The telescope used for this determination is the Meridian circle, so mounted as to move always in the great circle, passing through the zenith and the North Pole of the heavens. Looking through the telescope of this instrument the astronomer sees in the field of view a series of parallel wires across which the star is observed to pass. As each wire is passed he closes the electric circuit which records the instant of crossing on the rotating drum of the chronograph. From this information can be determined the local sidereal time upon which all mechanical devices for registering time must depend. Without the assistance of the astronomer we would not be able to answer the question, "What time is it?" nor would the radio be able to broadcast the correct time.

CLEPSYDRA OR WATER CLOCKS

Clepsydra or water clocks were used before the days of the mechanical clocks, indicating the passage of time by the dropping of water from one vessel to another. Some of these water clocks became quite complicated and gave the hours of the day and at times were even made to strike a bell. The hours were originally of varying length at different times during the year, the period of daylight and darkness each being divided into twelve parts. The daylight hours were longer during the summer months than during the winter months. This was indicated upon these old water clocks by an image which floated upon the surface of the water, rising as the level of the water changed and indicating by a pointer the passing hours, upon a vertical cylinder upon the surface of which were drawn a series of lines completely circling the cylinder. These lines were further apart during the daylight hours of the summer months requiring more water to pass from one vessel to the other before the level of the water should change by this amount. To indicate the hours of darkness the lines upon the cylinder were made closer together, therefore representing a shorter time.

THE SAND GLASS

The sand glass employed the same idea as the water clock except in this case sand was made to flow from the upper to the lower bowl. The sea captain of an age that is past determined his speed by casting over-

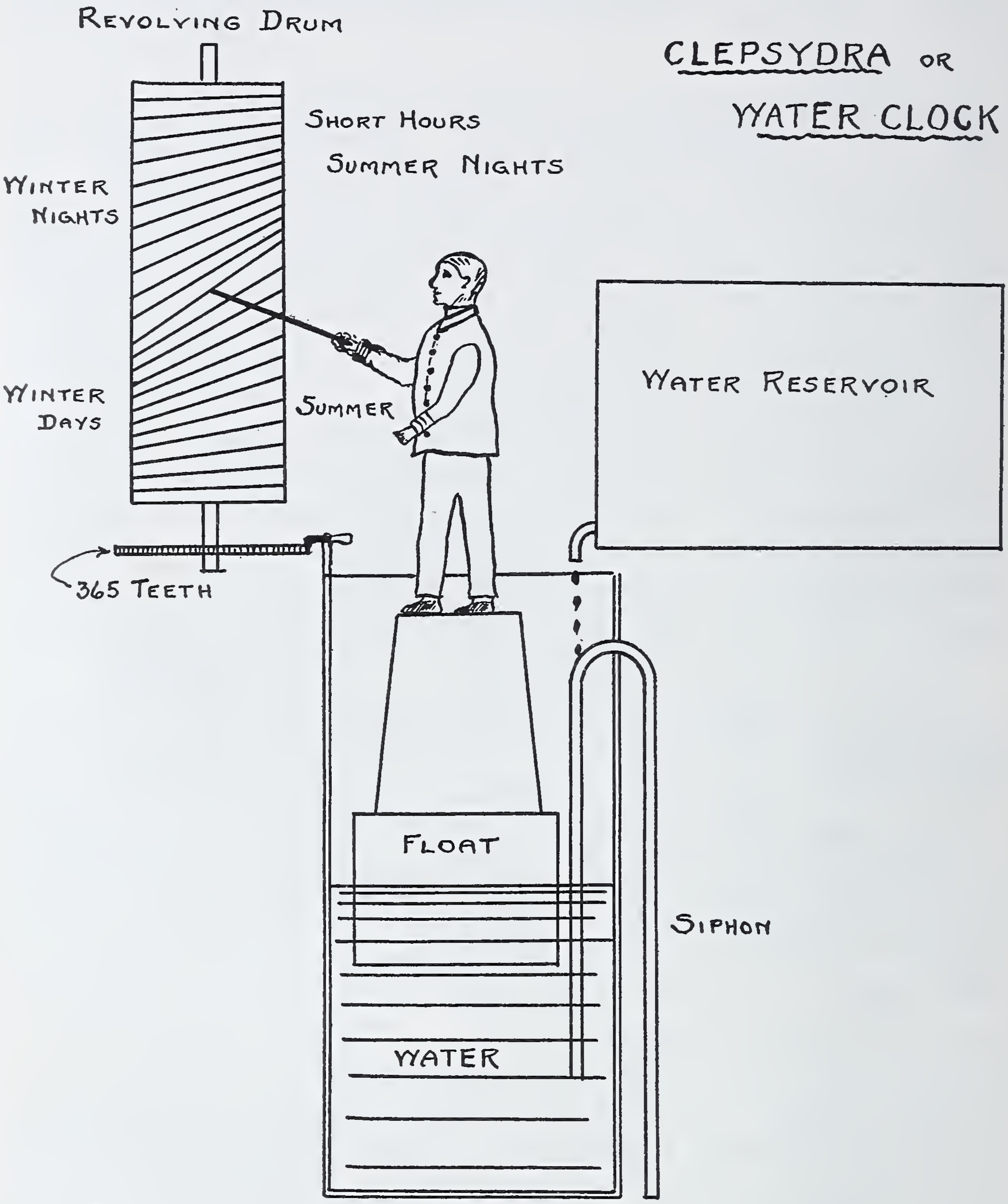


Fig. 3.

board a log to which was fastened a string with knots at equal intervals. Turning the sand glass as the log struck the water he would count the knots as they passed through his fingers during the time indicated by the sand glass. Still other forms of time indicators

were used such as candles and oil lamps. Imagine going over to the old oil lamp to determine the time to go to bed. A graduated scale on the side of the glass showed the amount of oil that had been consumed and therefore gave an indication of the passage of time.

MECHANICAL CLOCKS

With the advance of civilization the application of the principles of mechanics was sure to be employed in the design of clocks. To record time by a mechanical device requires (1) a driving mechanism, (2) a means of transmission, and (3) a controlling device. A falling weight or

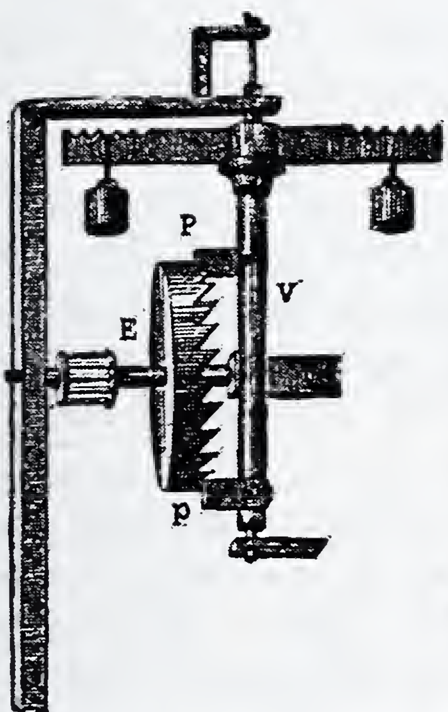


Fig. 4.

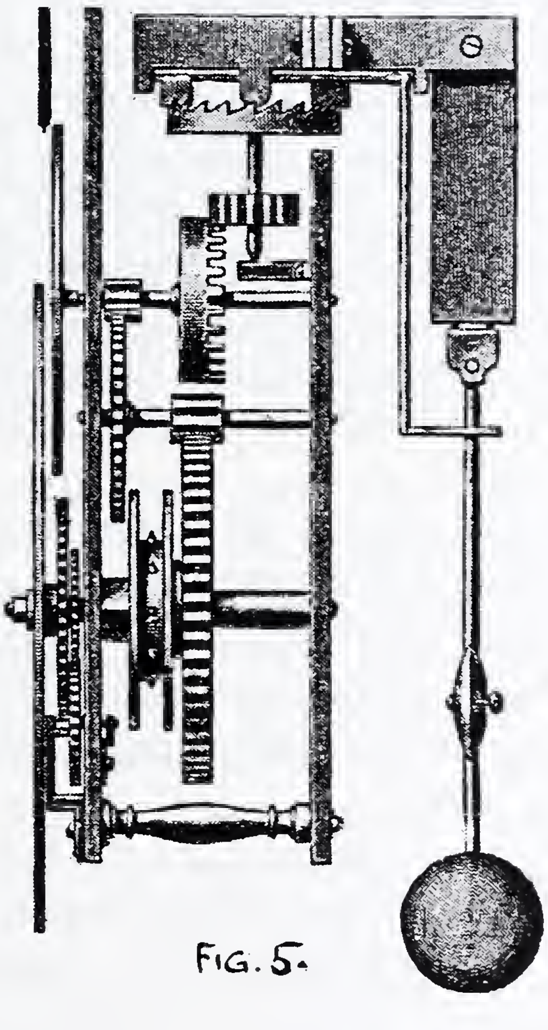


Fig. 5.

FIG 4.
DEVICK'S FOLIO
BALANCE.
FIG. 5. HUYGEN'S
PENDULUM CLOCK.

a coiled spring is the source of energy which is transmitted to a train of toothed wheels so arranged as to cause the motion of a hand upon a dial or merely to strike a bell. These early clocks required only one hand, the hour hand, since it was a good clock that gave the time to within half an hour.

It is the controlling mechanism that is most interesting. In the earliest clock that has come down to us, the clock made by De Vick, of Wurtenberg, about 1360 A. D. (see Fig. 4), we find controlling its movements a bar carrying small weights upon either end and

pivoted so as to move back and forth in a horizontal plane. The vertical shaft of this so-called foliot balance carried a pair of pallets which made contact with the teeth at the top and bottom of the crown wheel. Since the crown wheel was connected by the train of wheels to the shaft carrying the weight it was repeatedly forcing the top pallet in one direction and an instant later to force the lower pallet in the opposite direction. The effect was to cause the balance to swing back and forth acting as a control to the driving mechanism without which the wheels of the clock would turn with increasing speed as the driving weight fell to the ground.

As each tooth escapes and strikes against the pallet we have produced that familiar tick-tock sound. The first clocks in many cases were without a dial, the hour being indicated by the striking of a bell. The word clock is derived from the old English, "clokke," or the French, "cloque," meaning a bell. With the invention of the mechanical clock by De Vick the attendant of the older water clocks was no longer needed. The keeping of time was early connected with the church, the tower frequently surmounted by a pair of images, perhaps symbolic of the old attendant, who would strike the hour upon a bell.

About 1500 A. D. smaller house clocks came into use receiving all manner of decoration but the accuracy not being improved, these clocks were provided only with the hour hand. The invention of the main spring about this time made the timekeeper portable if one did not mind carrying something about the size of a turnip in his vest or coat pocket.

The year 1583 may be set down as important because of the observation of Galileo Galilei, then a young man of twenty years, as he watched the swinging of a hanging lamp in the Cathedral of Pisa. Comparing its motion to and fro with the rhythmic beat of his own heart he discovered that the period of oscillation remained constant at all times. Try this experiment for yourself by fastening a heavy weight of some kind to the end of a string and determine the time to swing from side to side. As the arc through which the pendulum swings gradually diminishes you may think that the time likewise decreases. Experiment proves otherwise. The period of oscillation depends upon the length of the pendulum and the gravitational attraction of the earth, unless the amplitude of the oscillation becomes very large, which is unlikely in any clock. A short pendulum swings rapidly, while one about thirty-nine inches long, used in the familiar

old grandfather's clock, requires about a second to swing from side to side. It is important to note that the pendulum is not the driving mechanism, that being the function of the falling weight or coiled spring. The pendulum serves as the most accurate means of mechanical control that has been discovered.

While Galileo certainly made the discovery with which we have credited him, he did not apply the pendulum to the clock in use at his time. The credit for the application of the pendulum to the clock mechanism is given to Christian Huygens, in the year 1657, when he took out a patent for the same. In the clock of Huygens the foliot balance is removed and the axis which carries the pallets is placed in a horizontal position. As the energy of the falling weight is transmitted through the wheels to the crown wheel, the axis carrying the pallets is forced back and forth, communicating this motion to the pendulum by means of an arm rigidly fastened to the horizontal axis. Since, as we have noted, the time of swing of the pendulum remains constant we are able to release one tooth of the crown wheel at a time and thereby maintain the motion of the clockwork at a constant speed.

The modern clock differs but little from that invented by Huygens. The crown wheel has been replaced by an anchor escapement which is given a rocking motion by means of the pendulum allowing one tooth to escape at each swing of the pendulum.

A clock is an ornament of beauty as well as usefulness. Many remarkable clocks have been made which indicate not only the time of day, but also the phases of the moon, the position of the planets, the day of the week, the month and the year. Such a clock is the old Strasburg clock which dates from the fourteenth century, a model of which can be seen in the Wanamaker store, Philadelphia.

The determination of the position of a ship at sea or in the air is dependent upon an accurate timekeeper. The necessity for such an instrument was important enough for the English Parliament to offer $100,000 to the inventor, John Harrison, in 1740, as a prize for his chronometer which made possible the determination of longitude at sea. When a ship leaves port its several chronometers are accurately set to Greenwich time, that is the time as recorded at the observatory of Greenwich, England, established in 1675, and from which it has been agreed to measure all longitude upon the earth. Since the earth rotates 15 degrees in one hour we can determine the longitude east or west of Greenwich if we make an observation of

the local time and have at hand a chronometer which is keeping Greenwich time. With the sextant the captain of the ship takes a shot at the sun and determines the instant of local noon at which time the sun has reached its highest point and is oberved to dip. But his chronometer indicates that it is 3 o'clock in Greenwich, making it certain that the ship has reached a position equal to three times 15 degrees or 45 degrees west longitude. An error in the chronometer of five minutes may mean a difference in position of eighty or ninety miles. The invention of the accurate chronometer, making it possible to keep correct time and the development of the radio communication makes a sea voyage today a very different thing than it was when Columbus crossed the ocean and did not even know where he had landed.

PRECISION CLOCKS

The precision clock in use at the various observatories presents a very different appearance, completely enclosed in its glass case so as to protect the movement from the dust and moisture in the air. Even this precaution does not remove all of the difficulties since we must guard against undue wear of the parts and the very frequent change in temperature which will cause the pendulum to vary in length and thereby change the period of oscillation. To compensate for these changes in temperature several devices have been used. The pendulum bob may consist of a cup of mercury which will expand as the length of the pendulum increases, thereby keeping the center of gravity in the same position, or the pendulum may be constructed of different metals in a grid iron shape so that as expansion of the metals takes place some of the rods will cause an increase in length while others, because of the method of attachment, will cause the pendulum to shorten.

We are living in a day when we keep cool without ice or keep warm without coal, at least it may seem that way when we plug in the electric cord. If we can do all these things electrically, why not have it keep time. In the Telechron, or electric clock, this has been accomplished. The driving mechanism is located at a distant generating station and the power conveyed, by means of the electric current, to the recording mechanism through a small electric motor in the clock case, operating on a 60-cycle alternating current. The controlling mechanism, unlike the pendulum or the balance wheel which is located in the clock, is found in the main generating station.

A master clock is connected to the dynamo, regulating its speed with almost absolute uniformity. Should the speed of the generator change by ever so little the master clock is so connected that it immediately brings it back again to the 60 cycles, thus exercising an accurate control over the electric output direct to the socket in your home. Why not use this modern means, plug in a Telechron and have electric time.

Our present method of registering time has many faults. When it is 7 A. M. in Philadelphia it is 12 noon in London, and in fact the same instant of time is recorded differently throughout the globe. We have become so firmly set in our ways that it is difficult to make a change—dinner time must occur at 12 noon. The astronomers, however, have agreed to make a change and their clocks everywhere indicate the same time, the time of the observatory of Greenwich. You receive a letter asking for an appointment at 8 o'clock and you are left in doubt; is it A. M. or P. M.? To be sure, such a letter belongs in the same class as the telephone call in which the party calls the station and says "My house is on fire, send the engines quick," and with that hangs up the receiver. This difficulty could be removed if the clock dial was made to indicate the hours from one to twenty-four consecutively.

You are all aware that in some parts of the globe the inhabitants at this moment are rising from their night's rest and preparing for the work of the day. Your time and my time are different and it is only by agreement that we have decided to use the same time. When the sun is on the meridian in Philadelphia it is 12 mid-day, while at all places to the east of Philadelphia it is afternoon and at all places to the west of Philadelphia it is forenoon. For every fifteen degrees that we move east or west this difference in time amounts to one hour and it is only at these points that we have decided to make the change in the time. In the United States we make three such changes in crossing from the Atlantic to the Pacific, all places within a time belt using the same time, while in fact the time is different on each meridian. Only as you travel north or south along a meridian does your time remain the same, but even then your time is not my time. Let me explain. Three men start out from distant places each with his correct time and so as to avoid the necessity of changing their watches decide to travel north along the meridian of the place from which each started. All goes well, dinner is served each day at that peculiar time, noon. After much traveling they meet at the North

Pole and exchange greetings, after which the hungry one suggests that it is dinner time, but the other, consulting his timepiece, says that something must be wrong, at which moment the third traveler remarked, "Why, we do not agree; each of us has a different time." Whose time is correct? Only an Einstein could answer such a question, so they return each one along the meridian he had previously traveled to find that their time agrees with the old folks at home. After all, time is only relative.

THE DATE LINE On a journey from China to California we observe a very interesting condition of affairs. As we cross the 180th meridian, if it is Tuesday, 3 A. M., we must change our date back to Monday, 3 A. M., and repeat the twenty-four hours again. Let us see why this is necessary. There is only an instant when it is the same day the world over. This occurs when it is 12 noon at Greenwich, England, since it has been agreed that this old observatory should be the point from which the longitude was to be measured. When it is 12 noon at Greenwich all places west have A. M. and all places east have P. M. on the same calendar day. But east meets west at the 180th meridian, where it is 12 midnight. For a place just to the east of the 180th meridian the day is just beginning, while for a place just to the west the same day is just about to close, therefore if one crosses the 180th meridian from the west, where the day is over, to the east, he must repeat the twenty-four hours which those places to the east of the 180th meridian have not recorded.

The hours of the day may be regarded as the stations along a railway. They remain relatively fixed in position while the earth moves by. A slight rotation of the earth from 12 noon at Greenwich and for some a new day has started. Thus it is Tuesday, perhaps 8 A. M. for a steamer traveling east when it reaches the 180th meridian, but it immediately becomes Monday, 8 A. M., when the meridian is crossed.

The watch and the clock give us an indication of the passage of time, but our bookkeeping requires an additional unit, the calendar day. I have placed the present calendar in a class with the sand glass. Every time it runs down you must turn it over. Have you ever really examined the calendar? Perhaps you know the rhyme, "Thirty days hath September, April, June and November," etc., but do you know that this verse appeared prior to 1390 A. D. in order

to assist in remembering these peculiar features. In this day of advancement in so many lines of activity, why should we be regulating our affairs with such an irregular calendar.

A SCIENTIFIC CALENDAR

A scientific calendar. Not much of a change from the present, keeping all the good features and removing the bad ones. It is proposed to replace the present calendar with one of thirteen months, of four weeks each, in which every month shall begin on Sunday. How often have you asked the question, "On what day will the Fourth of July occur this year," or made inquiry concerning some other holiday. In our new calendar the holidays will not change, always occurring on the same day each year. Could not these national holidays be celebrated on a Monday, thereby affording the opportunity for a week-end vacation instead of breaking into the middle of a week?

To do this it will only be necessary to add a month called "Sol," let us say, between the present months of June and July, every month to have four weeks, or twenty-eight days. To complete the yearly cycle we have one more day to add, "Year Day," the last day of the year. The new year begins on Sunday and every year is an exact repetition. What could be more satisfactory, but you say the Fourth of July will not be the Fourth of July and Christmas day will not be the birthday of our King. Let me call attention to a family record of George Washington, which may perhaps be new to you. "George Washington, son of Augustine and Mary, his wife, was born eleventh day of February 1731/32 about 10 in the morning," and you celebrate his birthday on the twenty-second of February. To understand this discrepancy it is necessary to consider the history of this old calendar which I have just cast aside.

Before the advent of printing it was necessary to keep the record of the days in a much different manner than at present. Sometimes a square stick of wood, called a "clogg," about twelve inches long with a hook in one end, served this purpose. Each day was represented by a notch cut in the edge, the notch for Sunday being somewhat larger. Each of the four edges contain the record for three months, the beginning of each month being indicated by an additional notch at right angles to the first near the right-hand end. To the left of the notches, marks or symbols indicate the golden numbers, referring to the phases of the moon, and to the right, various symbols depict the festival days.

One of the important features of the calendar in the early days was the keeping of the various festival dates.

March 1—The festival of St. David depicted by a harp.

June 29—The festival of St. Peter depicted by his keys.

June 24—The festival of St. John the Baptist depicted by the sword.

Many of these ancient festivals have come down to the present.

St. Valentine's Day is celebrated on the 14th of February in honor of the patron saint of lovers. He is said to have abolished the ancient custom of the boys drawing lots for the girls upon whom they should bestow their affection for the coming year.

The May Day Festival originally celebrated by the Romans in honor of Flora, the Goddess of Fruit and Flowers, has come down to the present. It is said that women danced naked in the street; the May Pole dance is all that has survived the progress of time.

April 1, "All Fools' Day," is of ancient origin. In France the salutation is somewhat changed. "Un Poisson d'Avril," you April fish, was showered upon the victim of some practical joke.

In order to inform the general public in matters concerning the calendar it was cut upn the faces of a square block of stone and placed in the Public Square. At the head of the column sometimes appeared the sign of the Zodiac and underneath the name of the month, the number of days, the day of the Nones, the hours of the day and night, the name of the sign through which the sun passed, the agricultural labors appropriate to the month and the principal festivals.

EVOLUTION OF THE CALENDAR

The early history of the calendar is somewhat in doubt but the indications are that at the time of the founding of Rome more than 2500 years ago, the year began in March since the months of September, October, November and December refer to the numerical order 7, 8, 9, 10. The number of days in the month was either 30 or 31, making in all only 304 days for the 10 months. Just how the difference between this and the time for a complete revolution of the earth around the sun was accounted for is not clear. Numa, who followed Romulus as King of Rome, we are told divided the year into 12 months of 29 and 30 days, alternately adding January at the beginning and February at the end of the year. This was in general a lunar calendar depending upon the changing phases of the moon. Because of the superstition of the people regarding even numbers one day was

TABLE I

EVOLUTION OF THE CALENDAR

	About		302 A.U.C.		708 A.U.C.	709 A.U.C.	746 A.U.C.	753 A.U.C.	2335 A.U.C.	2505 A.U.C.	2681 A.U.C.
	750 B.C.		452 B.C.		46 B.C.	45 B.C.	8 B.C.	1 B.C.	1582 A.D.	1752 A.D.	1928 A.D.
	Romulus Year—10 Mts.	Numa Year—12 Mts.	Months Rearranged	Intercalary Month Mercedonius	Sosigenes Julius Caesar Last Year of Confusion Equinox 3 Mts. Off	1st Julian Year Leap Year Every 4th Year Equinox March 25	12 Leap Years Added Instead of 9 9 B.C.-3 A.D. Common Years	Dionysius Suggested the Change 1280 A.U.C. Bonifacius III Made Change 1360 A.U.C.	Lilius Pope Gregory XIII 10 Days Dropped 1700—1800 1900 Common Years Equinox March 11	New Style Adopted in Great Britain 11 Days Dropped	Jan. 1 Sunday Leap Year
		Days	January		Jan.	Jan. 31	Jan. 31	A.U.C.	$\frac{\text{Century}}{400} = \text{Leap Year}$		Does Not
	Days	1 January 31	February	22 Days	Feb.	Feb. 29–30	Feb. 28-29	to B.C.			Recur Until
1	March 31	2 March 29	March	23 Days	Mch. ← 23d.	Mch. 31	Mch. 31	A.D.			1956
2	April 30	3 April 30	April	4 Years	Apr.	Apr. 30	Apr. 30				
3	May 31	4 May 29	May	377 Days	May	May 31	May 31			Sept. 1	Error in
4	June 30	5 June 30	June	355	June	June 30	June 30			Sept. 2	10000 Years
5	Quintilis 31	6 Quint. 29	Quintilis	378	Quint.	Quint. 31	July 31			→ 11d.	2d, 14h, 24m
6	Sextilis 30	7 Sext. 30	Sextilis	355	Sext.	Sext. 30	Aug. 31		Oct. 3	Sept. 14	
7	September 30	8 Sept. 29	September	4 | 1465	Sept.	Sept. 31	Sept. 30		Oct. 4	Sept. 15	Year
8	October 31	9 Oct. 30	October	366¼ d.	Oct.	Oct. 30	Oct. 31		→ 10d.		4000 A.D.
9	November 30	10 Nov. 29	November		Nov. 33d.	Nov. 31	Nov. 30		Oct. 15		Not a
10	December 30	11 Dec. 30	December	22 d. -x 3	Dec, ← 34d.	Dec. 30	Dec. 31		Oct. 16		Leap Year
	304	12 February 29		in 3rd period	355d.	365¼d.	365¼d.				
		355		of 8 yrs.	445d.						

added to the month of January, making a total of 355 days for the 12-month period. Since this was still short of the period of revolution of the earth the seasons were observed to shift. This condition was somewhat improved by the addition of an intercalary month called Mercedonius which took place between the 23d and 24th of February and amounted to 22 or 23 days on alternate years. This averaged 366¼ days during each four-year period and the extra day was allowed for by using 22 days three times in the third period of eight years.

Such an arrangement of the calendar was certain to be confusing, especially when we learn that the Pontiff was likely to adjust the same according to the political desires of his friends. In the year 708 A.U.C., Julius Cæsar considered the problem of the calendar of sufficient importance to call upon an eminent astronomer, Sosigenes, to make the necessary adjustment, the Equinox at this time was about three months in error because of the failure of the Pontiffs to intercalate the added days or because of the difference between the actual and the calendar year.

The year 708 A. U. C. has been called the last year of the confusion and is perhaps the longest calendar year we shall ever record. The intercalation of the month of Mercedonius added the usual 23 days and in addition it was found necessary to add two additional months of 33 and 34 days between the months of November and December, making a total of 445 days for the year. The following year was the first Julian year consisting of 365 days and months of 30 and 31 days alternately with the exception of February, which had only 29 days. Every fourth year one day was to be added to the month of February. Even this calendar was not foolproof. After the lapse of 36 years it was discovered that 12 leap years had been intercalated instead of 9 and in order to rectify this the next 12 were considered as common years.

By this time the names of two months had been changed in memory of Julius and Augustus Cæsar and the number of days in each month somewhat rearranged. The next important notation of the calendar, seldom referred to, was suggested by Dionysius about 1280 A. U. C. In order to assist in the spread of Christianity throughout the world, he considered the importance of a change in the beginning of the era. Up until this time the years had been numbered from the founding of the City of Rome (A. U. C.), and it was accordingly decided to renumber the years, counting from the birth

of Christ. The year 753 A. U. C. was considered as the year 1 B. C., and the following year 1 A. D. Our present notation has therefore only been in use for a little more than 1300 years.

That the intercalation of the extra day in February caused some disturbance in the order of worship may be inferred from the following notation from the prayer book.

"When the years of our Lord may be divided into four even parts, which is every fourth year, then the Sunday Letter leapeth and that year the psalms and lessons which serve for the 23rd day of February shall be read again the following day, except it be Sunday, which hath proper lessons from the Old Testament appointed in the table to serve for that purpose."

The addition of the supplementary day at the end of the month of February was made by Charles II.

The Julian Calendar continued in use for 1600 years when the difference in this calendar from the actual year had amounted to ten days. The existence of this difference had been known for some time and Roger Bacon gave it much concern, informing the Christians that they would soon be eating meat when they should be observing Lent.

Not until 1582 A. D. was a change made in the existing calendar. Pope Gregory XIII issued a Bull which restored the date of the vernal equinox to the 21st of March by calling the day following October 4 the 15th of October, thus dropping ten days from the calendar. In order that this should not occur again the number of leap years was reduced, the years representing the centuries were to be leap years only when they were divisible by 400. The year 1600 was therefore a leap year and the years 1700, 1800 and 1900 common years.

The adoption of this reform calendar did not take place at once in all countries. Germany retained the older calendar until 1700 and Great Britain and the Colonies did not make the change until the year 1752 A. D. It is on this account that the date of the birthday of George Washington is recorded in the family record as having occurred on the 11th day of February, 1731/32. In England, up until 1752, the year began on the 25th of March and caused much confusion since according to the Gregorian calendar the beginning of the year had been moved to January 1.

When does the year begin? This question has been somewhat of a puzzle. The old Babylonian year began with the vernal equinox and the first month was named after the Bull. The sun no doubt was

TABLE II

SOLAR CYCLE 28 YEARS

Recurrent Correspondence between day of the month and day of the week.

Common years 365 days, next January 1 falls one day later.

Leap years 366 days, next January 1 falls two days later.

$$\frac{\text{Year A.D.} + 9}{28} = \text{N} + \text{Year in Solar Cycle}$$

$$\frac{1928 + 9}{28} = 69 + 5$$

Year of Solar Cycle	January 1	Falls On	Sunday Letter
5 (Leap)	1928	Sunday	AG
6	1929	Tuesday	F
7	1930	Wednesday	E
8	1931	Thursday	D
9 (Leap)	1932	Friday	CB
10	1933	Sunday	A
11	1934	Monday	G
12	1935	Tuesday	F
13 (Leap)	1936	Wednesday	ED
14	1937	Friday	C
15	1938	Saturday	B
16	1939	Sunday	A
17 (Leap)	1940	Monday	GF
18	1941	Wednesday	E
19	1942	Thursday	D
20	1943	Friday	C
21 (Leap)	1944	Saturday	BA
22	1945	Monday	G
23	1946	Tuesday	F
24	1947	Wednesday	E
25 (Leap)	1948	Thursday	DC
26	1949	Saturday	B
27	1950	Sunday	A
28	1951	Monday	G
1 (Leap)	1952	Tuesday	FE
2	1953	Thursday	D
3	1954	Friday	C
4	1955	Saturday	B
5 (Leap)	1956	Sunday	AG

in Taurus at this equinox about 4700 B. C. As early as 5700 B. C. the Sumerians celebrated the beginning of the year at the vernal equinox. Why therefore the change? The date of perihelion of the earth for the year 1928 is January 4th, but this date has continually advanced, occurring on December 21st 1250 A. D. Can this have influenced the calendar reform?

That the present length of the year is a satisfactory one will be observed since the difference between the calendar year and the actual year only amounts to two days in 10,000 years. The year 4000 will not be a Leap Year.

A friend called attention to a beautiful calendar hanging upon the wall. It had been a gift received several years ago and she was so pleased to think that she could use it again. But this was 1928, a very peculiar calendar. It has not had the dust removed from its pages for forty years.

How many different calendars do we have?

Our method of recording time has the defect that a given date does not fall on the same day year after year. We have fourteen different calendars if we restrict ourselves to a record of only the days and the date. Seven for the common years and seven for the leap years. The leap year calendar is usually used at intervals of twenty-eight years, but since the year 1900 was not a leap year the calendar for 1928 has not been used since the year 1888. The Scotchman who saves the present calendar will not be able to use it until the year 1956. This is not the case with the calendar for the common years which repeat three times in the twenty-eight-year cycle.

This cycle of 28 years is called the Solar Cycle. The year 1 A. D. by convention was made the tenth year of a cycle, and in order to find the year in the solar cycle for any other year we add nine to the number of the year and divide by 28, the remainder is the year of the cycle.

$$\frac{1928 + 9}{28} = \frac{1937}{28} = 69 + 5$$

The year 1928 is the fifth year of solar cycle.

The Lunar Cycle of 19 years was discovered as early as 433 B. C. a period of 19 Julian years $365\frac{1}{4}$ days = 6939 days 18 hours and the time of 235 lunations 29 days, 12 hours, 44 minutes, 2 seconds = 6939 days, 16 hours, 31 minutes. If we consider the phases of the moon for any month, *i. e.*,

May, 1928,	Full moon	May	4th
	Last quarter		12th
	New moon		19th
	First quarter		26th

it is 19 years before this is repeated.

The years of this lunar cycle have been numbered from 1 to 19 and the year 532 A. D. was considered as the first of a cycle. These numbers are known as the Golden Numbers and the cycle restores the new moon to the same day of the month. The year 1928 is the tenth year of the present cycle.

The combination of the Solar Cycle of 28 years and the Lunar Cycle of 19 years results in the so-called Dionysian Cycle of 28 x 19 or 532 years after which the new moon falls on the same day of the month and the same day of the week.

To use these cycles each day of the year has been given a letter, thus January 1st is lettered (A), January 2d (B), January 3d (C), January 7th (G), January 8th (A), etc. The first Sunday of the year denotes the Sunday Letter for the year and every Sunday throughout the year will have the same letter. If

January 1 is Sunday	the Sunday Letter is A
January 1 is Monday	the Sunday Letter is G
January 1 is Tuesday	the Sunday Letter is F
January 1 is Wednesday	the Sunday Letter is E
January 1 is Thursday	the Sunday Letter is D
January 1 is Friday	the Sunday Letter is C
January 1 is Saturday	the Sunday Letter is B

The leap years require two Sunday letters. With the knowledge of the Sunday Letter it is not difficult to determine the day of the week corresponding to any date. The Sunday Letter for 1928 (see Table III), a leap year is AG, indicating that January 1 was Sunday. Beginning with March the calendar for the year whose Sunday Letter is G must be used. To find the day of the week, for example, corresponding to May 9th of the year 1928, we find according to the Table IV, it falls on a Wednesday.

This is one of the outstanding defects of the present calendar in that the same date does not occur on the same day year after year. The present calendar reformers are attempting to remedy this defect by use of a calendar consisting of thirteen periods of twenty-eight days

TABLE III

THE DOMINICAL OR SUNDAY LETTER

Hundreds of years after Christ

Years by which the given year exceeds the hundreds of years				1700 2100 2500 2900 3300 3700	1800 2200 2600 3000 3400 3800	1900 2300 2700 3100 3500 3900	2000 2400 2800 3200 3600 4000
				C	E	G	B A
1	29	57	85	B	D	F	G
2	30	58	86	A	C	E	F
3	31	59	87	G	B	D	E
4	32	60	88	F E	A G	C B	D C
5	33	61	89	D	F	A	B
6	34	62	90	C	E	G	A
7	35	63	91	B	D	F	G
8	36	64	92	A G	C B	E D	F E
9	37	65	93	F	A	C	D
10	38	66	94	E	G	B	C
11	39	67	95	D	F	A	B
12	40	68	96	C B	E D	G F	A G
13	41	69	97	A	C	E	F
14	42	70	98	G	B	D	E
15	43	71	99	F	A	C	D
16	44	72		E D	G F	B A	C B
17	45	73		C	E	G	A
18	46	74		B	D	F	G
19	47	75		A	C	E	F
20	48	76		G F	B A	D C	E D
21	49	77		E	G	B	C
22	50	78		D	F	A	B
23	51	79		C	E	G	A
24	52	80		B A	D C	F E	G F
25	53	81		G	B	D	E
26	54	82		F	A	C	D
27	55	83		E	G	B	C
28	56	84		D C	F E	A G	B A

To use the table: In the vertical column having the century at the top and in a horizontal line with the year of that century you find the Sunday letter.

each. A new month "Sol" will be inserted between June and July and the 365th day will be December 29, to be known as Year Day. In leap years an extra day will be added at the end of June. Each month will begin on Sunday and the same date each month will always fall on the same day.

One other cycle requires mention, the so-called Cycle of the Indiction, a fifteen-year cycle introduced by Constantine in 312 A.D. as a period for the regulation of the imperial taxes. It is of interest

TABLE IV

TABLE SHOWING THE DAY OF THE WEEK

Month	Dominical Letter						
Jan. Oct.	A	B	C	D	E	F	G
Feb. Mch. Nov.	D	E	F	G	A	B	C
Apr. July	G	A	B	C	D	E	F
May	B	C	D	E	F	G	A
June	E	F	G	A	B	C	D
August	C	D	E	F	G	A	B
Sept. Dec.	F	G	A	B	C	D	E
1 8 15 22 29	Sun	Sat	Fri	Thu	Wed	Tue	Mon
2 9 16 23 30	Mon	Sun	Sat	Fri	Thu	Wed	Tue
3 10 17 24 31	Tue	Mon	Sun	Sat	Fri	Thu	Wed
4 11 18 25	Wed	Tue	Mon	Sun	Sat	Fri	Thu
5 12 19 26	Thu	Wed	Tue	Mon	Sun	Sat	Fri
6 13 20 27	Fri	Thu	Wed	Tue	Mon	Sun	Sat
7 14 21 28	Sat	Fri	Thu	Wed	Tue	Mon	Sun

To use the table: For the month in question pass horizontally to the Sunday letter for the year. In the vertical column below and in line with the date will be found the day of the week.

chiefly because of its connection with the Julian Period. Joseph Scaliger (1540-1609) conceived the idea of a period which should include all three cycles, and so established the Julian Period of 7980 years obtained by multiplying the 19 (Lunar Cycle) by 28 (Solar Cycle) by 15 (Indiction). This cycle was considered as beginning January 1, 4713 B. C. on which date the beginning of the three cycles coincide. The year 1928 is therefore 1928 + 4713 or the 6641st of

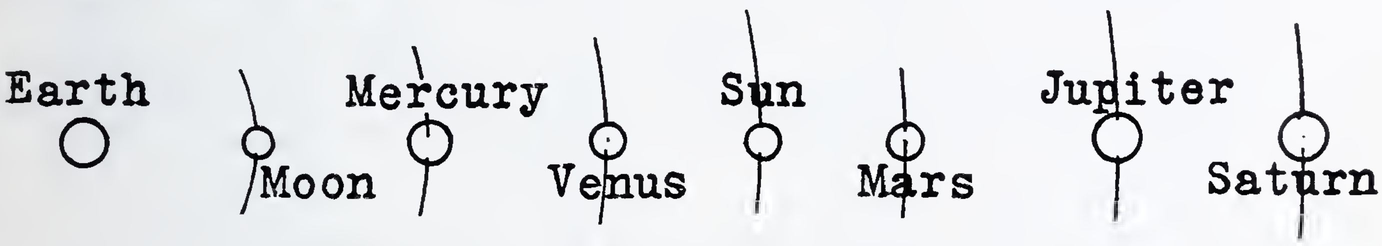
the Julian Period. The only sure manner of a correct enumeration of the time is a record of the number of days, January 1, 1928, is the 2,425,247th day of the Julian Period.

Many other points of interest in the calendar might be considered. On one occasion I found myself reading a book upon this interesting subject published in 1815 the pages of which I found necessary to cut.

TABLE V

ORDER OF DAYS OF THE WEEK

EGYPTIAN ASTRONOMY



Each Planet ruled over an hour of the day

1	Saturn	Sun	Moo	Mar	Mer	Jup	Ven	Sat
2	Jupiter							
3	Mars			(Tiw)		(Thor)		
4	Sun							
5	Venns							
6	Mercury							
7	Moon							
8	Saturn	Sun	Moo	Mar	Mer	Jup	Ven	Sat
9	Jupiter							
10	Mars							
11	Sun							
12	Venus							
13	Mercury							
14	Moon							
15	Saturn	Sun	Moo	Mar	Mer	Jup	Ven	Sat
—	———							
22	Saturn							
23	Jupiter							
24	Mars	Mer	Jup	Ven	Sat	Sun	Moo	Mar

DAYS OF THE WEEK

The Egyptian astronomers gave the earth a place in the center of the system of planets with the following order, arranged according to the supposed distance from the earth; Moon, Mercury, Venus, Sun, Mars, Jupiter, Saturn, seven in all as they knew them. Each hour of the day was ruled over

by one of the planets beginning with Saturn and continuing through the 24 hours of the day. The first hour of the second day was therefore ruled over by the Sun, the next by the Moon, etc. Thus the

TABLE VI

THE ROMAN MONTHLY CALENDAR

Days of Month	March, May, July October (31 d)		January, August December (31)		April, June, Sept. November (30)		February (28-29 D)		
1	Kalendis		Kalendis		Kalendis		Kalendis		
2	VI		IV	Ante	IV	Ante	IV	Ante	
3	V	Ante	III	Nonas	III	Nonas	III	Nonas	
4	IV	Nonas	Pridie Nonas		Pridie Nonas		Pridie Nonas		
5	III		Nonis		Nonis		Nonis		
6	Pridie Nonas		VIII		VIII		VIII		
7	Nonis		VII		VII		VII		
8	VIII		VI	Ante	VI	Ante	VI	Ante	
9	VII		V	Idus	V	Idus	V	Idus	
10	VI	Ante	IV		IV		IV		
11	V	Idus	III		III		III		
12	IV		Pridie Idus		Pridie Idus		Pridie Idus		
13	III		Idibus		Idibus		Idibus		
14	Pridie Idus		XIX		XVIII		XVI		
15	Idibus		XVIII		XVII		XV		
16	XVII		XVII		XVI		XIV		
17	XVI		XVI		XV		XIII		
18	XV		XV		XIV		XII		
19	XIV		XIV		XIII		XI		
20	XIII		XIII		XII		X	Ante	
21	XII		XII	Ante	XI	Ante	IX	Kal.	
22	XI	Ante	XI	Kal.	X	Kal.	VIII		
23	X	Kal.	X		IX		VII		Leap
24	IX		IX		VIII		VI		VI
25	VIII		VIII		VII		V		VI
26	VII		VII		VI		IV		V
27	VI		VI		V		III		IV
28	V		V		IV		Pridie		III
29	IV		IV		III		Kal.		Pridie
30	III		III		Pridie				Kal.
31	Pridie Kalendus		Pridie Kalendus		Kalendus				

planet which ruled over the first hour of the day gave to that day its name.

We have borrowed the names of the months from the Romans but the names of the days have been derived from the Saxons. Thus

Tuesday is named for the Saxon God of War Tiw, instead of the Roman God Mars, and Thursday for the God of Thunder Thor, instead of Jupiter.

The Romans divided the month into three parts: the Calends, the Nones, and the Ides. The Calends fell on the first day of the month and in some way were connected with the new Moon. It was the day on which the Roman Pontiff called the people together to apprize them of the festivals and sacred days.

The Ides occurred on the thirteenth or the fifteenth day of the month and the Nones nine days before the Ides. The Romans counted their days backward from these three fixed days, the day following the Nones was the eighth day before the Ides. In addition to this subdivision the different days of the month were given letters from A to G and then repeated, making what might be regarded as an eight-day week.

Many suggestions have been made in the past for other changes in the calendar, but whether we permit the mathematician or the moon to regulate our activities upon the earth will all depend upon how soon we are willing to cast aside the superstition of the past and launch out in a purely scientific way to record the progress of events past, present and future. All those in favor of a change in the calendar, vote "yes."

HOW MUCH DO YOU WEIGH?

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FEW QUESTIONS CONCERN the human race more directly and universally than the subject of weights and measures. As a matter of fact this question is taken for granted. It is one of daily routine, for we are all either buyers or sellers and are therefore involved in its meshes.

SCOPE

Weights and measures are fundamental necessities of commerce, industry and science. Measurement is required in the exploration of lands and waterways, in the construction of roads, bridges, railroads, buildings and other engineering works, in the manufacture of foods, in the purchase and sale of materials, in the preparation of compounds of every description. Weights and measures are essential to all barter of goods, whether it be the "heap" or "pile" of ancient times or the fractions of a cent quoted on the cotton or wool market. They are required alike in all construction work, whether it be the rule of thumb procedure or the precision and accuracy of the millionth of an inch in optical work.

Adley B. Nichols, B. Sc., Phar. D.

The pharmacist with his weights and measures compounds prescriptions which mean health and life to the sick. Weights and measures are used to determine the essential proportions in analyses of compounds, and upon precision rests the ability to reproduce these results. Likewise the manufacturer must accurately weigh, measure and test his materials to secure perfect construction. Surveying and navigation would be very primitive were it not for the rigorous measurements of base lines, the accurate determination of angles, precise leveling, even to the delicate determination of latitude. Weights and measures are essential in the development and statement of industrial and scientific facts of all kinds and the modern growth of science can easily be laid to the development of precision, our life

itself fitting into measured schedules of time and place. The carefully measured curves of every tool in industry are alive with the treasured skill of a race of craftsmen. Measurement is a miracle worker. We give a measured curve to glass to match a measured defect of the eye and thus restore sight to the aged and perfect the vision of youth. With a series of lenses the laboratory clinician measures the life stream and upon his findings one's time upon this earth is subsequently lengthened.

Feeding the race, a primary necessity, creates countless recipes, which set to measure the skill of the cook and thus make reproducible a host of delectable dishes. The success of every feast depends upon the measurements which assure perfection in the culinary masterpieces. We go further and measure calories and nitrogen for bodily energy and repair and thus we are able to feed scientifically.

WEIGHTS AND MEASURES OF PRIMITIVE MAN

To trace weights and measures to their origin let us go back to primitive man and try to consider how he adapted himself to his surroundings. Here we would probably find measurement closely linked with number, as he grouped items together, and once grouped, he would unconsciously compare the various pieces, using one of the group as a unit. This in turn led to the necessity of fixing a permanent standard by which he could make comparisons at all times. Likewise, if it took a certain number of days to make a journey, the distance covered in one day came to be looked upon as a unit of travel or distance. The distance a man could run without stopping became another unit, the distance covered by a step at walking pace another.

For measuring still smaller distances the primitive man would take the various members of the body as units of measure. The length of the foot, the breadth of the hand, the width of a finger, the span of the extended fingers, the length of the forearm or the distance between his finger tips with the arms outstretched. These were natural units by which he could express himself and even today we find them still referred to in the foot, the palm, the digit, the span, the cubit and the fathom. All of these distances figured in the early system of measures, and in fact there was a great diversity in the measures of early civilization due to the fact that only the convenience of the individual had to be considered. However when several persons were concerned in the comparison of the size of an object or some other kind of measurement, it was necessary to conform to the

convenience of the group rather than that of the individual, and with the development of trade there was also added the idea of equity. If a pace or a span was a convenient unit for a number of individuals, it would soon become necessary to specify the class of individuals or better yet the single individual whose pace or span was to be the standard, for naturally the pace of a man only four feet tall would not compare favorably with one who was six feet tall. Thus by common consent one of the group would be selected to provide the proper units, and as a matter of convenience to all, these units were probably marked off on some surface where they could be available for all as standards of comparison. Very frequently the one selected to provide these standard units was the chieftain or ruler of the tribe and as a matter of fact many of the units in use today date back to that practice. As late as the time of Henry I the length of the English yard was fixed by the length of the king's arm and when thrones changed hands new units of measurements were required to conform to the new arm.

EARLY BARTERING

It probably did not take primitive man long to discover that if he gathered an extra supply of food on one day he would not need to worry about it on the next and before long he probably acquired the habit of accumulating large quantities of supplies. His neighbor would do likewise but probably with another line of material and so they began to barter, each exchanging some of his supplies for those of his neighbor. Here standards were required and eventually the "bunch" or the "pile" was replaced with units of more definite value. The earliest records seem to show that the first basis of exchange was the ox or cow, which in turn soon found its equivalent in a certain amount of gold. Gold was a universal metal although somewhat scarce and consequently could be given definite value in terms of cows or oxen. This would involve some crude method of capacity as perhaps a goose quill for measuring powdered gold and finally the use of a primitive balance in which seeds were used as weights. The common seed for this purpose was the Rati or Gunga (wild licorice) seed. Because of their uniformity in size and their permanence, these seeds were well adapted to this purpose. They were followed by barley and wheat and this again brings us up to our present period

and English weights, for according to the statute of Henry III in 1266, the English penny should weigh "thirty-two grains of wheat well dried and gathered out of the middle of the ear." The jewelers unit of weight, the carat, is another example of a standard developed from a similar source as it is taken from the Arab "carob" or bean.

Early weighing was apparently confined to the weighing of gold, and later silver and copper, in trade only, until the 17th dynasty or about 1200 B. C., and it was not until the seventh century B. C. that coined money was used. That this weighing of metals by the balance was universal we see in the first book of the Bible, where in the story of Abraham's dealing with the sons of Heth "Abraham weighed four hundred shekels of silver" with which to pay for his burial place. This incidentally is the first reference to weighing in written history. As a natural result of such weighing, units of stone or metal were made, based on the weights of seeds.

DEVELOPMENT OF WEIGHTS AND MEASURES

Capacity measures were gradually developed probably beginning with the capacity of the cupped hands or that of an egg shell or gourd, or a cylinder shaped from a piece of bamboo. These were followed by jars and containers fashioned from clay, and of a convenient size to meet the daily needs in carrying water, grain and other similar necessities. Eventually some of these articles were accepted as units or standards of capacity and frequently a particular vessel was used only as a unit of measure for a particular seed or fruit. Many examples of this type have been unearthed in Egyptian ruins in the form of glass vases or receptacles on each of which is imprinted the amount or weight of content and also the name of the contents, probably not to show what was in them but to show for what kind of seed the vessel was a true measure. These measures and stamps date as far back as 600 A. D.

BODY UNITS OF MEASUREMENT

As before stated the earliest measures of length were based upon the various units of the body, the fathom of six feet, the cubit or one-quarter fathom, nineteen to twenty inches, the span or one-half cubit of nine inches, the palm or four fingers equal to one-third the span or one-sixth cubit or three inches, and the digit, the middle finger breadth of three-quarters of an inch, one-twelfth span or one twenty-fourth of the cubit. From this division of the cubit into six palms, the span into

twelve digits, came the division of the day into watches and hours, the years into months, etc., in other words, our duodecimalism.

THE CUBITS AND THEIR DEVELOPMENT

Like other units, the cubit was at first an arbitrary standard, but as time went on it became necessary to fix its value by law and so by about the fortieth century B. C. it had definitely been established as a length equal to 18.24 inches. There seems to be no doubt today but that the cubit of Egypt was obtained through the measurement of the earth, for though there are no written records available, one of the greatest and oldest monuments in the world shows this, and establishes the fact that early measures were not hit or miss standards but were apparently developed through scientific means. The monument referred to is the great pyramid, for its base is 500 cubits long on each side and this is found to be exactly half a meridian or nautical mile or 500 Egyptian fathoms in perimeter.

A vessel representing a cubic span or foot gave rise to another popular unit, the talent, used for weight and also for capacity. A larger container capable of holding a talent of grain, wheat for instance, became another unit, the bushel. This was followed by another subdivision of the talent, the pound, a portion of this in turn being used as the standard of weight for coins. Then a number of coins eventually developed the ounce and again 12 or 16 ounces became a pound.

All of these units passed to and fro from one people to another and were mixed and replaced one with another in their trading and in the changing of hands as one tribe or nation conquered or triumphed over the other. This resulted in there being many different values for the same stated unit, not much different as a matter of fact, however, from the situation under which we labor today.

BIBLE UNITS

Among the many interesting units of weight and measure those mentioned in the Bible are typical of the ones in use in general throughout the early period covered by the Egyptian, Roman, Babylonian and Grecian empires. Among these are the following:

Units of length

The body units already mentioned
The *stadium* of 400 cubits (1/8 mile)
The *mile* of 10 stadia (1/5 more than an English mile)

Units of measure

The *log*—smallest liquid measure—(¾ pint)
The *cab*—⅙ seah (3½ pints)
The *omer*—(dry measure) 6¼ pints
The *hin*—1½ gal.
The *seah*—⅓ ephah (2½ gal.)
The *ephah* (dry) 3 seahs (7½ gal.)
The *bath* (liq.) 3 seahs (1/10 homer)
The *lethech* (dry)—15 seahs (16 pecks)
The *homer*—(dry) 10 ephahs (32 pecks, 1 pint)
The *sextarius* or *pot*—Roman meas. for liq. (1½ pints)
The *choenix*—Grecian meas. for capacity (1½ pints)
The *firkin*—(7½ gal.—same as Hebrew bath.)

Weights and Coins

(Coins were originally weights) (value based on weight)
Gerah or *piece of money* = 1/20 shekel
Bekah = ½ shekel
Shekel—from which all other weights and coins are computed
Maneh or *Mina*—gold = 100 shekels
silver = 60 "
Talent = 3000 shekels
Mite = ⅜ farthing
Farthing = 1/10 denarius
Penny or denarius = Roman silver coin

The evolution of weights and measures, ancient and modern, is explained by the story of the cubits and the talents. These have come down in the many actual measurements of monuments and buildings, and even original wooden measures actually used by architects are still in existence, so that it is possible to actually determine definite cubit standards. Weights of stone, gold, haematite, glass, lead, and bronze and in shapes varying from bronze lions to barrels, eggs, glass scarabs, gold plates and cuboids are available to tell their part of the story of the development of weights and measures.

An interesting record of early measurements is found in the writings of a Chinese traveler who reports in 629 A. D. on measures of India.

"In point of measurements, there is first of all the yojana; this from the time of holy kings of old has been regarded as a day's march

for an army. . . . In the subdivision of distances a yojana is equal to eight krosas, a krosa is divided into 500 bows: a bow is divided into four cubits: a cubit is divided into 24 fingers, a finger is divided into 7 barleycorns and so on to a louse, a nit, a dust grain, a cow's hair, a sheep's hair, a hare's down, a copper water, and so on for seven divisions, till we come to a small grain of dust; this is divided sevenfold till we come to an excessively small grain of dust (anu): this cannot be divided further without arriving at nothingness, and so it is called the infinitely small (paramanu)."

From the time of the fall of the Roman Empire on through the dark ages and the middle ages there is little to be learned of weights and measures. There were no large empires holding sway, such as there had been, and the small kingdoms scattered over Europe made no great impress upon the times. Old standards were lost or destroyed, their names only remaining, and it was not until about 1300 A. D. that the system of weights and measures as it applies to us today began to again develop itself.

INFLUENCE OF EARLY ENGLISH UNITS

England naturally played an important part in the development of weights and measures and many of our present day units are derived from old English standards. Thus it is of interest to briefly review the more outstanding English units as they were authorized.

In 1266 by an act of Henry III the pound was established as 12 ounces, the wine gallon at 8 pounds and the bushel at 8 gallons.

Originally the troy and avoirdupois ounces weighed the same, but as English units were based on the weights and values of coins, when the values of the coins were later changed it was found that the avoirdupois ounce was 42½ grains lighter than the apothecary or troy ounce.

In 1618 the troy weight (derived from Troyes, France, a great trading center) was adopted by the College of Physicians of London so that today the apothecaries labor under a double system of weights, buying their supplies by the avoirdupois and selling by the troy system, a constant source of trouble and annoyance.

In 1760 a determined attempt was made to prepare definite standards and as a result the yard and troy pound were standardized and these same units are really in use today.

In 1816, a desire to prepare new standards which could be easily recovered in case of loss, resulted in the establishment of the

Imperial system, now in general use in Great Britain, thus adding still another set of units where there were already too many.

It will be noticed later that most of these early English units, now discarded, supplied the standards for our United States weights and measures, so that a unit of a given name is not likely to mean the same thing in England as it does to us. By the act of 1816 the yard of 36 inches was developed through the beat of a carefully regulated and controlled pendulum. The troy pound of 5760 grains was determined by comparison with a given measure of distilled water under certain conditions. The Imperial gallon contains 277 cubic inches, equivalent to 10 avoirdupois pounds of water and is divided into 8 pints, the pint however being divided into 20 ounces, each equivalent to 437½ grains of water. The bushel was made up of 8 Imperial gallons.

EARLY UNITED STATES UNITS

In the United States, standards used by the first colonies were of course those brought over from England before the act of 1816, and each colony more or less also developed units and standards of their own. Washington, as early as 1790 had urged the adoption of uniform standards in all the states, but it was not until many years later, in 1836, that Congress furnished each state with a duplicate set of standards, the troy pound of 5760 grains, the avoirdupois pound of 7000 grains and the yard of 36 inches, all based on the old discarded English standards. The U. S. gallon was taken from the old wine gallon of England, containing 231 cubic inches, equal to 8.33 av. pounds of water, and this was divided into 4 quarts of approximately 58 cubic inches each. The quart in turn equals 2 pints and the pint 16 ounces. The fluid ounce, however, contains 454 grains of water.

In 1866 the metric system was legalized in the U. S. although it was not made compulsory, and as international copies of the metric units were available to all nations, these have since served as standards upon which our common units are based, the yard for instance being $\frac{3600}{3937}$ of a meter.

In dry measures, the bushel, again differing from the British unit, was derived from an old abandoned English standard. It contains 2150 cu. in. equal to 77.2 pounds of water and is divided into 32 quarts containing approximately 67 cu. in. each. Thus it is seen

that the dry and liquid quarts vary considerably, the former containing about 16 per cent or 1/6 more than the latter.

THE AVOIRDUPOIS SYSTEM

The avoirdupois (av.) system of weights is used almost entirely for all commodities excepting precious metals, jewels and chemicals. It dates back to the Roman period, being derived from the Attic mina of 6845 grains or 1/60 of the large Attic talent. The mina was also divided into 16 ounces, closely representing our modern ounce.

The largest unit of the avoirdupois system is the ton of 2240 pounds called the long ton, although there is also a short ton which contains only 2000 pounds. The pound of 7000 grains is divided into 16 ounces of 437½ grains each and the ounce is also divided into fractions of ½, ¼, ⅛. The latter, called a dram, is not however of the same value as the apothecary dram, nor is the ounce or pound of the same value as the apothecary ounce or pound. As a matter of fact we notice in the avoirdupois system itself that the ton is not always a ton.

THE TROY SYSTEM

The troy weights, consisting of a pound of 5760 grains is divided into 12 ounces of 480 grains each. This is the official standard for use in regulating coinage in the U. S. mint. The troy ounce of 480 grains, divided into 8 drams of 60 grains each and 3 scruples of 20 grains each, is used by the pharmacist today in dispensing medicines and is usually referred to as the apothecary system of weights. It must be remembered, however, that the pharmacist buys his medicines under the avoirdupois system and in selling them by the apothecary system he must constantly be alert and carefully determine his cost and selling price or he will wonder how it is that he has no profits at the end of the year.

The Metric System

ORIGIN

The credit for establishing and first adopting the metric system goes to France. For some time they had realized how confused were the various systems in use and at the time of the French Revolution they took advantage of the situation and established the metric system in 1799. However, due credit goes to an English inventor, James Watt, for proposing the decimal notation and the commensurability of the various units of weight, volume and length.

UNITS The basis for this new system, decided upon by a commission appointed to study the question, was a unit called the *meter* which was equal to one ten-millionth part of a quadrant of the earth through Paris, or in other words, one forty-millionth of the circumference of the earth at the poles, roughly 39.37 inches. The *liter* was defined as the volume of the cube of $\frac{1}{10}$ of a meter and the *gram* as the weight of $\frac{1}{1000}$ liter of distilled water at its maximum density of 4° C. These represent the fundamental units of the metric system for length, capacity and weight respectively. Other units are derived through divisions or multiplications by ten, and thus it is frequently called the decimal system.

SIMPLICITY The simplicity of the metric system may be readily visualized in the following chart.

Ratios	*Lengths*	*Volumes*	*Weights*
1000 000.			Millier or tonneau
100 000.			Quintal
10 000.	Myriameter		Myriagram
1 000.	Kilometer	Kiloliter or stere	Kilogram
100.	Hectometer	Hectoliter	Hectogram
10.	Dekameter	Dekaliter	Dekagram
1.	Meter	Liter	Gram
.1	Decimeter	Deciliter	Decigram
.01	Centimeter	Centiliter	Centigram
.001	Millimeter	Milliliter	Milligram

The metric system was repealed by Napoleon for a few years but again was made law and since that time practically every nation and country in the world except Great Britain and the United States have adopted it, while the latter two recognize it but do not make it compulsory.

INTERNATIONAL BUREAU Because of its international character and application, an International Bureau of Weights and Measures was established near Sevres, France, in 1875.

Here, in an underground vault, guarded by several doors, keys of which are in the hands of different countries, are stored the inter-

national prototype platinum-iridium meter bar and kilogram. Only once in six years is this vault opened and then only with great formality and in the presence of representatives of all countries.

This bureau is managed by an international committee and its object is to protect and safeguard these international standards and to make prototypes of them for the various subscribing countries. The United States prototypes of these units are in the custody of the Bureau of Standards at Washington. Extremely exacting care is required in making copies of these standards and their lengths are accurately determined and compared by the use of the microscope and light rays, the fundamental unit of the length in the metric system today being the wave length of a red ray of cadmium. This unit was adopted by the International Conference in 1927.

CONFUSION OF OUR COMMON UNITS

In the foregoing, we have mentioned some of the countless units of weights and measures now in use in our own country and if we were to attempt to cover them all we would find it an endless task. For instance we could consider the rod, chain, furlong, skein, the land or the sea mile, the acre, barrel, pipe, clove, sack, nail, ell, to say nothing of the way in which all of these units vary according to states and use.

Our most common units are confusing enough and that old story of "which is the heavier, a pound of gold or a pound of feathers"? is not the type of joke we think it is. If we went to the mint and bought a pound of gold we would receive 12 ounces (troy pound), and if we then proceeded to buy a pound of golden feathers we would receive 16 ounces (avoirdupois pound) and find that we did not have money enough to pay for it. Or let us try to buy some coal with which to keep warm on these cold wintry days. We order a ton but how much do we get? Well that depends on who you are, where you are, and how much money you have, together with whom you buy your coal from. So again we see that a pound is not a pound and a ton is not a ton any more than an ounce is not an ounce and neither is it an ounce.

How well we all recall the days spent with our arithmetics trying to figure out the value of a crop of grain on a farm measuring 2325 ft. by 1245 ft. and producing 25 bushels to the acre, the price of grain being quoted at 2⅔ cents per pound. And that was only one problem! Think of the tables involved and the time spent in

learning such tables! Now compare these with the metric system where from one small unit, the centimeter for instance, one could so easily construct the entire group covering length, volume and weight. A cubic centimeter multiplied 1000 times gives the liter by which we could measure volume. That same cubic centimeter filled with water would weigh one gram, our unit of weight, and by multiplying the side of that cubic centimeter by 100 we obtain the meter, our unit of length. Multiply the meter by 1000 and we have the kilometer, the unit for distance. The meter squared gives us a means of determining area usually expressed in terms of 100 square meters or the *are*. Thus we see the intensely practical application and the simplicity of the system with its units of tens and now we notice how much it resembles our own coinage system, the best in the world. It does not take a child long to discover that 10 cents made a dime, 10 dimes, a dollar and so forth and he finds it so easy to visualize and compare one coin with another.

That the time will come when the United States and Great Britain will adopt the metric system is certain and were it not for definitely organized opposition on the part of a group who will not or can not understand its great value, we would be operating under it at the present time.

These opponents will not listen to any reason and offer all sorts of obstacles. They consistently refrain from thinking in terms of the metric systems but prefer to use old units and then say "now look at that equivalent in the metric system." For instance they will show you that a mile equals 1.609 kilometers or a kilogram equals 2.205 pounds and thus try to set up a sense of confusion, where were the metric system adopted we would soon become accustomed to thinking in terms of kilograms and kilometers and then a kilogram would be equal to 2.6792 troy pounds or 2.2046 av. pounds and a kilometer would equal 0.6214 land miles or 0.5396 nautical miles and the tables would be turned. Wonderful units these pounds and miles!

THE YARD AND KING HENRY'S NOSE

Time does not permit of further detail of this most interesting phase of weights and measures but let me quote what Alexander McAdie has to say about it all.

"The schoolboy trying to memorize the table of liquid weights and measures suffers because an hour later he doesn't know whether

three drams make a scruple or eight scruples make a dram. Now he has it!

Three drops make one minim,
Eight minims make one scruple
Three scruples make one dram
Two or three drams make one drunk."

And he continues: "More than eight hundred years ago there lived a king—an English king, one Henry—early in his reign gray bearded Councilors declared that in their opinion it would be nice to have a measure of length called a yard; and this should be the distance between the tip of royal Henry's nose and the end of the royal thumb. The king's nose may have been large or small or tilted upward. Moreover, the distance may have been measured when the King's nose was swollen, for royal noses can hit a door post in the dark just like common noses. And the royal thumb may have been stubby or spatulate. We of the twentieth century should never forget that every time we buy a yard of ribbon we measure more or less accurately the distance between a defunct exroyal nose and a departed exroyal thumb. Henry is gone and he took his nose and his thumb with him. We cannot very well standardize our yard by comparison with the original: nor can we even find the bit of string or stick or whatever they used to determine the exact distance between the proboscis and the thumb."

Now is the time to put an end to this burlesque and unite all the world with a common bond capable of being understood by all nations both far and near, a bond that would do a great deal to settle the world and make it a peaceful planet on which to live.

Enforcement

ORIGIN OF CUNNING AND CRAFTINESS

Another phase of the question of weights and measures is that in relation to its enforcement. This is no new problem by any means for we only need turn to the Bible to find one reference after another bearing on this subject. The Israelites were so accustomed to the use of weights and measures that they began to employ false weights and wrong measures, with the result that not once but many times their prophets and teachers were forced to emphasize honest dealing in matters of measurements and the weighings of daily life. Turning

to Leviticus XIX 35 we find the following: "Ye shall do no unrighteousness in judgment, in measures of length, of weight or of quality. Just balances, just weights, a just ephah and a just hin, shall ye have." and in Deuteronomy XXV 13-16: "Thou shalt not have in thy bag diverse weights, a great and a small. Thou shalt not have in thy house diverse measures, a great and a small—a perfect and just weight shalt thou have; a perfect and just measure shalt thou have."

Josephus gives credit to Cain for the introduction of weights and measures saying, "He also introduced a change in that way of simplicity wherein men lived before; and whereas they lived innocently and generously while they knew nothing of such arts, he changed the world into cunning and craftiness."

And indeed this cunning and craftiness still persists today and were it not for a great body of efficient and well organized men who are continually on the alert for such practices, we would constantly be required to carefully examine everything we purchase to insure our receiving what we pay for. Even today we occasionally find flagrant cases where a dealer will connive to cheat by one means or another but it is nothing compared to the practices found in our own city for instance 15 years ago, when the Bureau of Weights and Measures was first established to fight this evil.

ILLEGAL BALANCES AND WEIGHTS

A few examples of the cases found may be of interest. Probably the worst trouble arose through the use of scales which were unfit from age or were "fixed" to give wrong weights. Some of the illustrations here show this feature very strikingly. For instance the ice scale with a 50-pound weight records the neat sum of 64 pounds; a spring scale found in a small shop shows 5½ pounds for a pound weight; a spring balance, so frequently found in meat shops, shows the graduation advanced 2 ounces; a counter scale, with bearings so worn that again an additional 2 ounces is required to give the proper equilibrium; a counter balance with lead and iron tied underneath the pan. Then again worn out weights and altered weights caused trouble. One set of weights shown were picked up at a junk dealers; he used the light weight when he bought the goods and the heavy one when he sold them. Light weights of this kind were frequently found in the shops and came to be known as Saturday night weights, as they were usually brought out on Saturday night when

business was at its height. The practices of tying a string to the scale and drawing down on it with one hand or by a foot lever to indicate additional weight, or bearing down on the scale with the tip of a knife were all frequently met.

ILLEGAL MEASURES

Baskets and dry measures were another source of trouble, but here deception was usually always intentional. Examples here show baskets with false bottoms; baskets made with staves, one stave being removed from the side and the basket drawn together again; baskets with wires drawn tightly around the center thus decreasing the capacity; baskets that are tall and deep, making it difficult to pack; baskets of nearly the

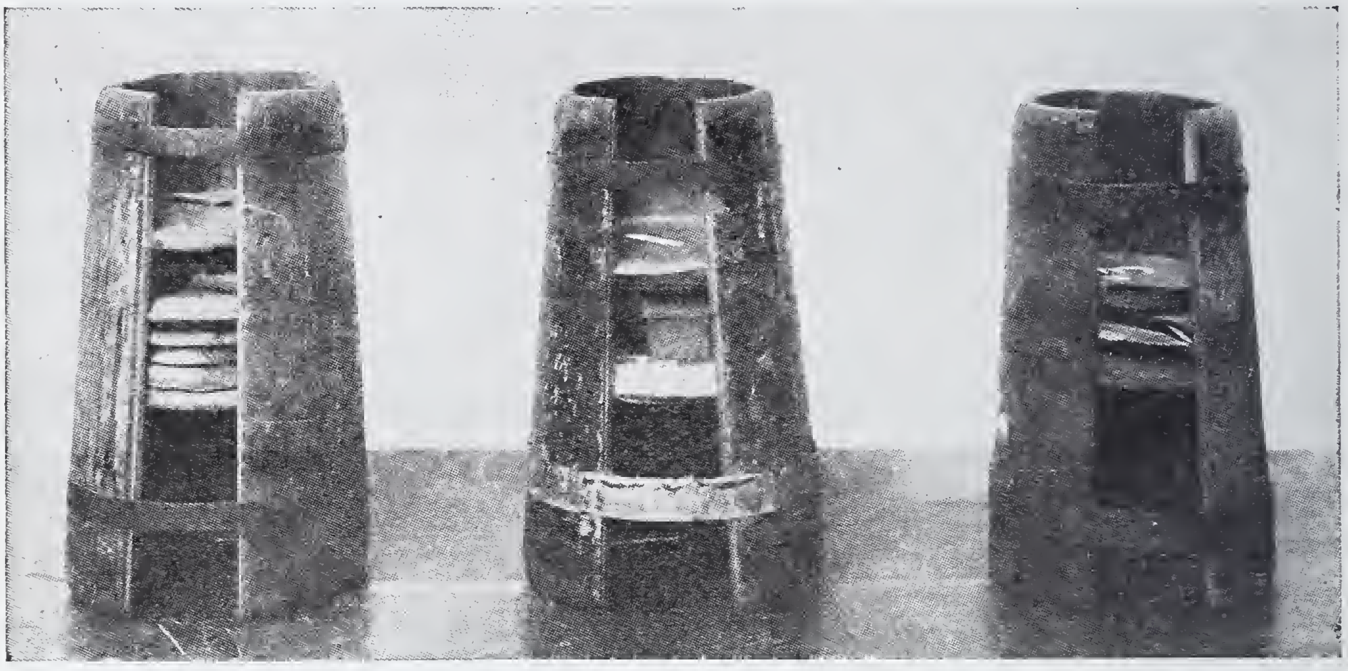

Fig. 1—Fraudulent Dry Measures. (Partition stuffed and sides also drawn together, resulting in a shortage of from 47 per cent. to 56¼ per cent.)

same size but not marked and the smaller frequently passing for the larger unit. Liquid measures also came in for their share of error, with false bottoms inserted or sides dented in, thus decreasing volume again. Milk bottles varying by a wide margin, yard sticks made or worn short, together with short measurements through the old custom of driving brass tacks into a counter, as a means of taking measure. Gasoline tanks and pumps, oil cans or bottles and in fact everything that had to do with weights and measures were found at fault. These are only a few of the hundreds of examples found, and when we see the figures and find that some 185,000 separate pieces of weighing and measuring apparatus were examined by the bureau in its first year of activity and that 31 per cent. or about ⅓ of these were confiscated, we can see what it means to have such a bureau. Estimates

prepared on that basis showed that in Philadelphia alone over $40,000,000 was being lost to purchasers per year. Today this has been almost entirely eliminated and we can usually rest assured that we are getting what we pay for, particularly when we trade at reputable shops.

ENFORCEMENT UNITS

The enforcement of these standards begins with our national government where we find the Bureau of Standards as custodian of the standards for the United States. The Bureau supplies the individual States with copies of these standards, the States in turn supplying the cities and towns. Large organizations will even have their own equipment with which to test out the various types of measuring and weighing devices under their control, recognizing this as a business obligation and it is seldom that an official of a weights and measures bureau ever need concern himself over conditions in such an institution. Testing of weights and measures covers an endless array of material, from the ordinary types, as we might think of them, even on to include such things as water and gas meters. For the large scales used by railroads in weighing loaded freight cars, special test cars are constructed. The Bureau of Standards operates such a car, it being used to test out the various test cars and master scales with which most railroads are equipped. The railroads then send their test cars over their system, rechecking the scales in the various yards as they go along. A very carefully designed and sensitive master test scale recently installed in one of the shops of the Pennsylvania has a capacity of 150,000 pounds. In a test of 100,000 pounds this scale deviated only $\frac{3}{10}$ of a pound (less than five ounces) and in a recheck it showed only $\frac{1}{10}$ of a pound deviation. It is enormous in size but still of such delicate construction that by merely breathing on some of its levers is enough to change its indications more than a pound.

Scales and Balances

Scales or balances are probably more or less well known to every individual and today we have practically as many different and varied uses for scales as we have industries. The balances of the drug store, of the meat shop or grocery are more or less common but we shall see later where these are practically lost when we consider the many other applications of the balance.

EARLY WEIGHING

Several Bible references to weighing have already been mentioned and on the temple walls of Egypt we find the oldest known illustrations of the process of weighing. Here a scale appears with gold rings on one side, balanced by an ox head on the other. While early scales were crude in appearance, the underlying principles based on physical laws have not changed. True, these principles have been greatly elaborated upon in the development of this modern industry but the old Egyptian or Roman steelyard, consisting of an unsupported beam developed into a single lever scale, this into compound levers and so on until we now have scales with leverage systems which appear very complicated but fundamentally are based on the same physical laws which made the steelyard practical.

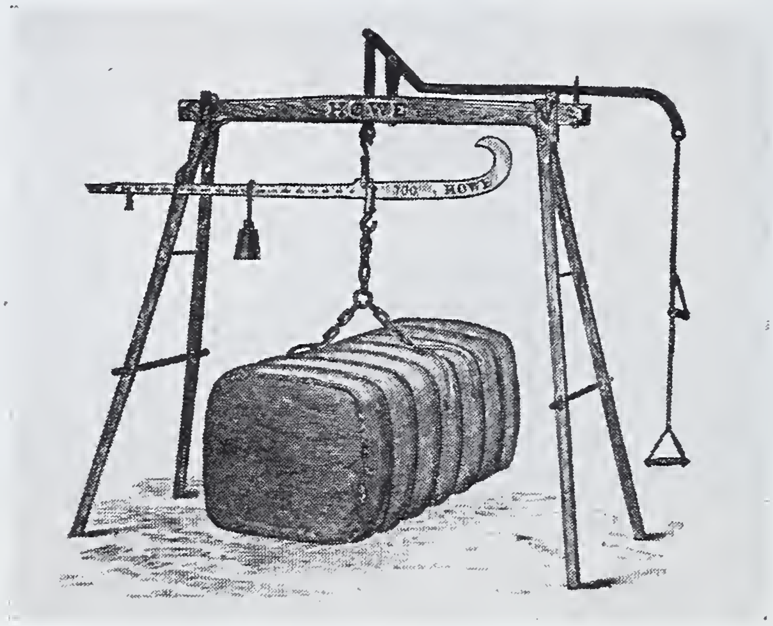

Fig. 2—The Steelyard Principle as Shown by a Cotton Beam.

SPRING BALANCES

In operating principle, scales might be conveniently classified into several groups. The first of these represents the simple spring balance, usually seen dangling from the rear of an ice wagon. This consists of a piece of heavy tightly coiled steel wire, having decided elasticity, to which an indicator is directly attached and which shows on a permanent scale the weight or pull of a mass when fastened by a hook to the lower end of the spring. Care is taken in manufacturing scales of this type to see that the coil or spring is checked before it reaches its critical point or that point where it would no longer snap back to its original starting position. These scales of course are not practical for exacting work.

Another application of this spring and one which can be made to give accurate results, is found in the dial face scale so frequently used in meat shops. The principle is the same here excepting that the needle or indicator is made to swing over a round dial, clock fashion, and very often two springs are involved to give better accuracy and so arranged that there is no change in the scale due to different temperatures and varied weather conditions. Valuable

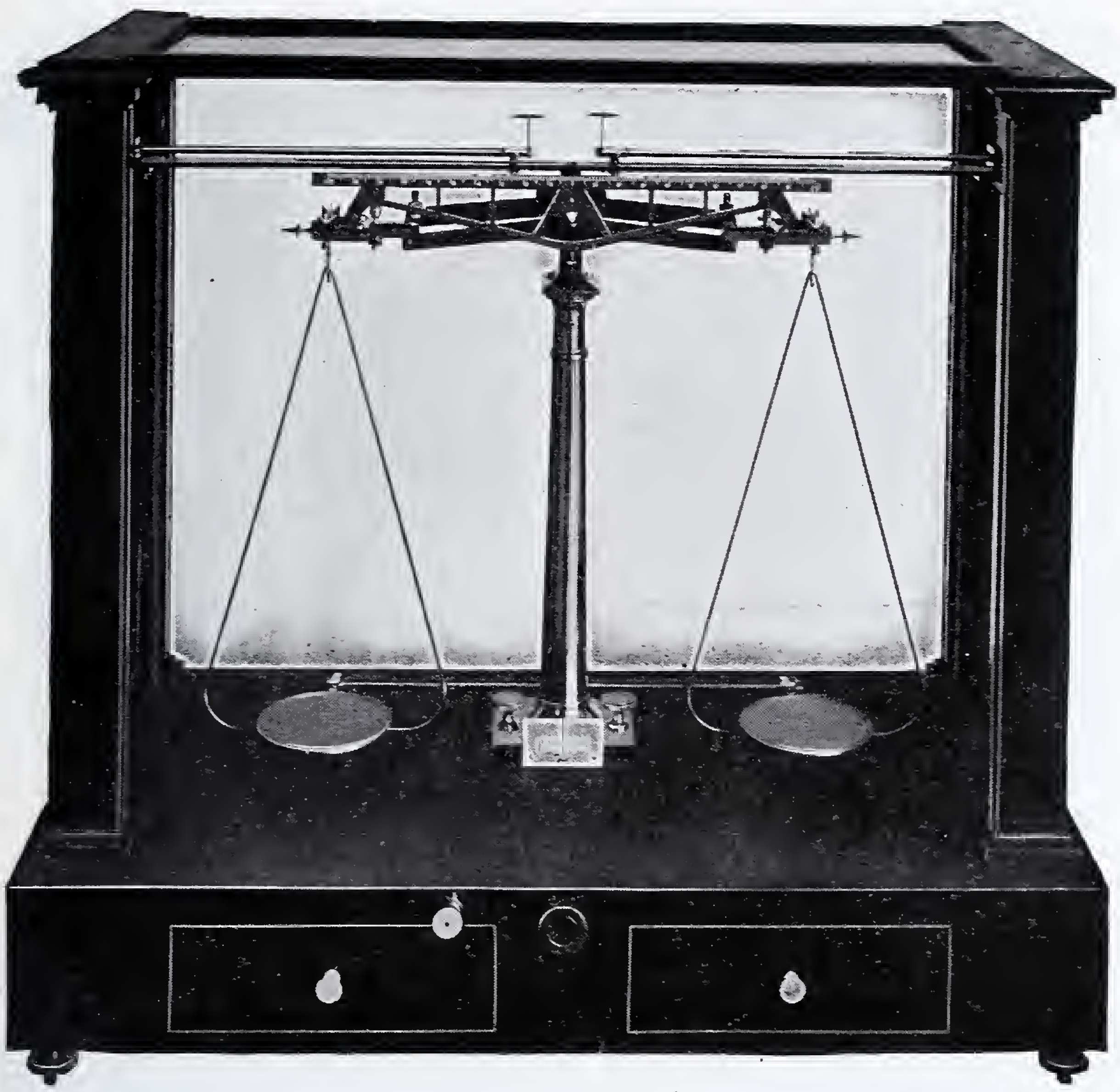

Fig. 3—Analytical Balance.

features of these scales lie in the fact that they are very convenient to use, they give rapid results, and there are no loose weights to handle, although for accuracy they do not compare with the lever type which rest on knife edges.

LEVER BALANCES

The second classification comprises the group of lever scales, based on the old steelyard, consisting of a single beam so hung that it is divided into two arms. If the arms are of equal length an object supported from one end will require a weight of equal mass on the opposite end to effect

equilibrium. If, however, and here is where its great practicability comes in, the beam is supported so that the two arms are unequal, then the masses required at the end of each section or lever are found to be inversely proportional to the length of the lever. For instance, if one lever is one foot in length and the other has a length of two feet, then a two pound weight on the first lever will only require a one pound weight on the second to counterbalance it. Visualize now

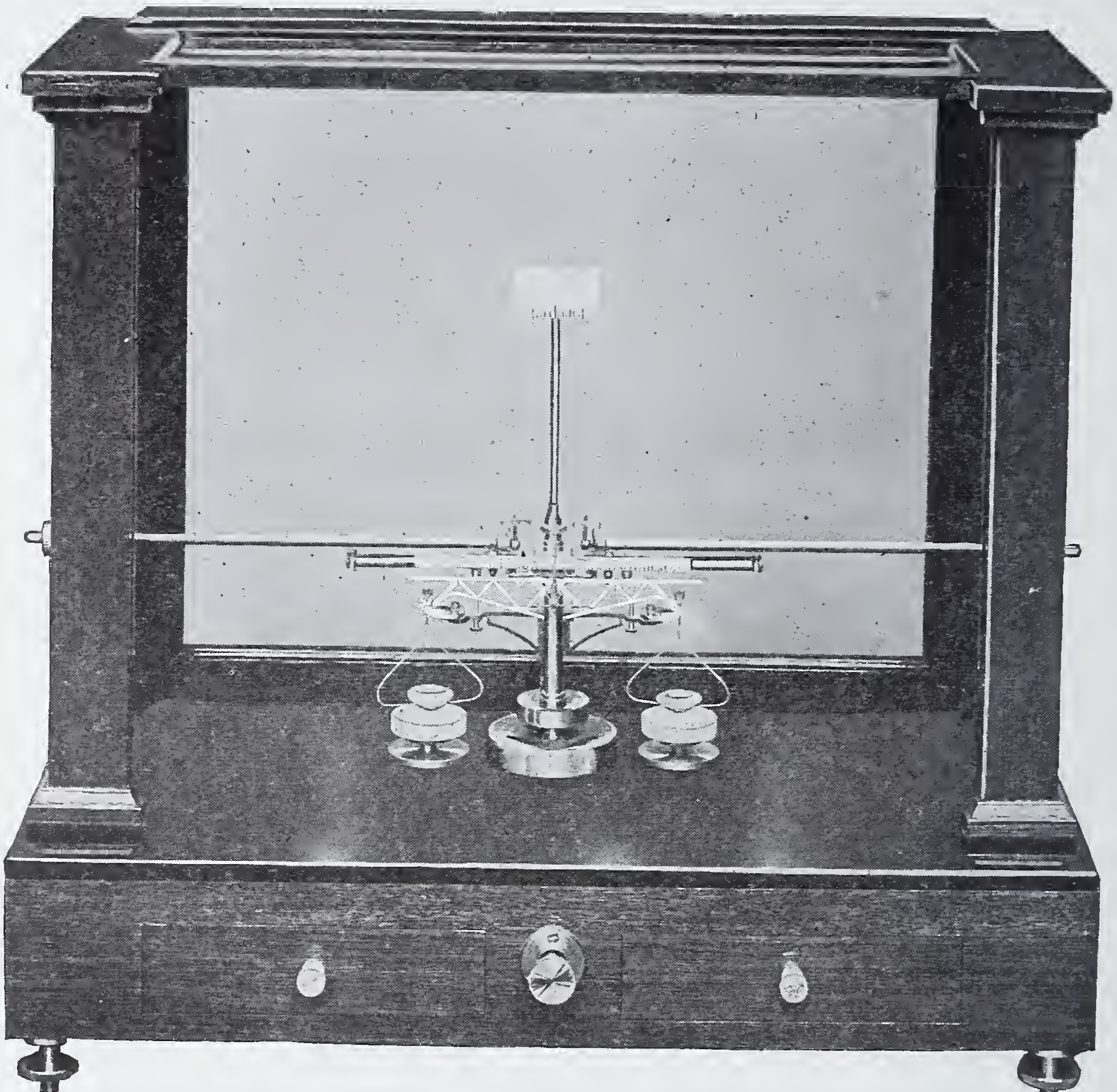

Fig. 4—Delicate Assay Balance.

such a beam, divided let us say into 2 inches and 8½ feet or 100 inches. A 50 pound weight on the 2 inch lever will then only require a 1 pound weight on the 100 inch lever to balance it, while a 10 pound weight would counterbalance 500 pounds. It is this principle which was used in early scales, and later by multiplying the levers this ratio was increased many fold until today we find scales capable of weighing a thousand tons and the readings still made on comparatively short bars.

In the group of equal arm balances we find those with the scale pans hung below the beam, a type principally used by pharmacists and analysts, owing to their extreme sensitivity, and those with the scale pans supported above the beam, as in the common counter scale found in pharmacies. The pharmacists prescription balance or the analytical balance we find made with the highest degree of care and skill and it represents the simplest as well as the

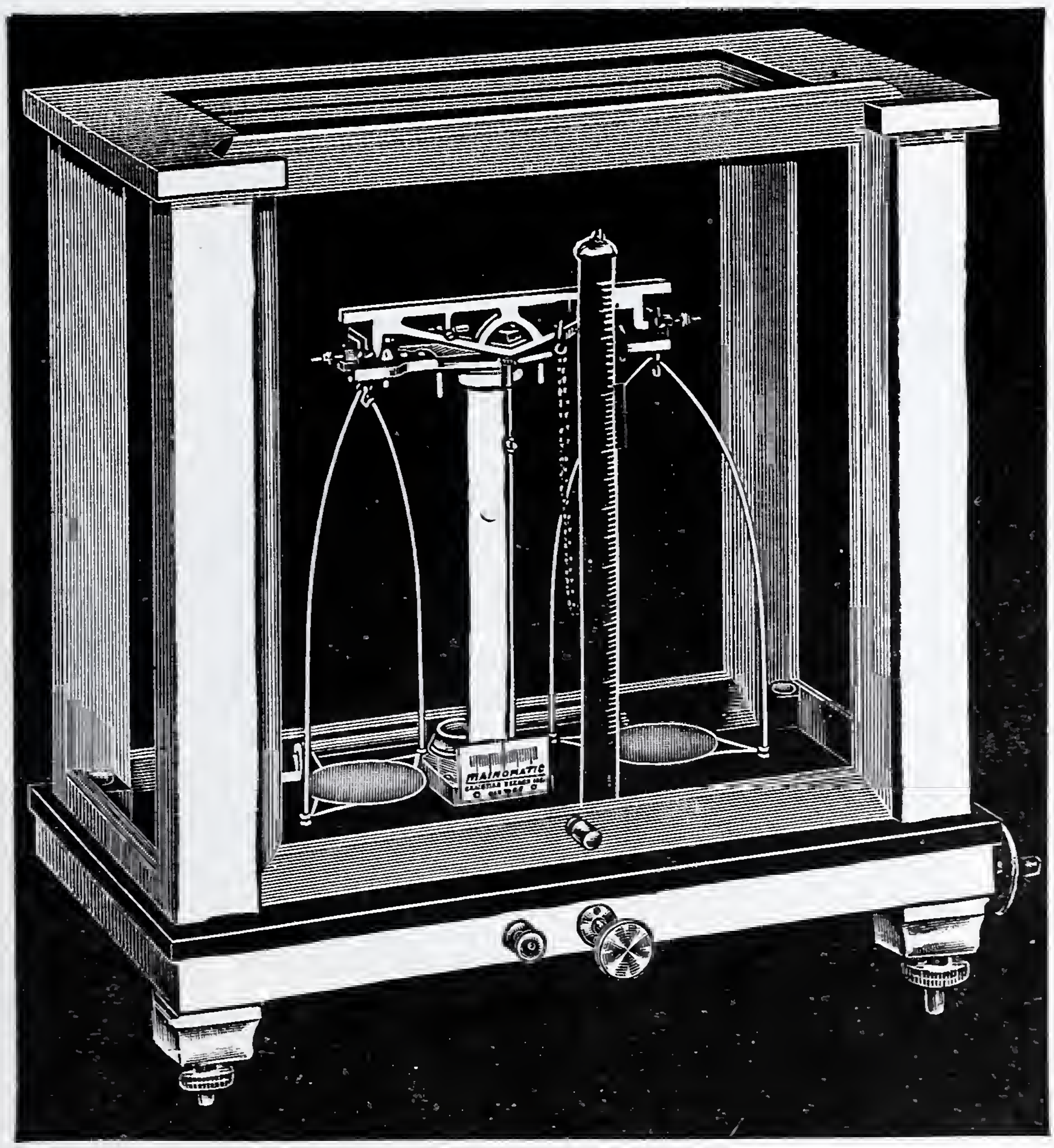

Fig. 5—Chainomatic Analytical Balance. (Fine adjustments are regulated by automatically raising or lowering the chain.)

most accurate although it takes care and time for adjustment. The beam is made of carefully selected metal as it must be firm and rigid under the heaviest load or strain. The beam is supported and the pans hung on knife edges of the hardest steel or agate, so that there is very little friction to slow up the action of the balance. Besides using loose weights many of these balances are equipped with graduated beams upon which small weights slide, thus capable of giving extremely fine subdivisions.

The group of unequal arm scales is so extended that it would be impossible to mention all of its applications here. The more common of these are recognized in counter scales, automatic personal weighing machines, platform scales in the industries, automatic computing scales and so on.

TORSION BALANCES

Still another class is represented by the torsion balance. The principle here is different from any we have mentioned heretofore and is based on the fact that when a steel band, for instance, is twisted out of its fixed or natural position, it exerts a strong pull or force to correct its position to normal. In the torsion balance this is taken advantage of by tightly drawing flattened metallic bands over rectangular forms, the beam and scale pans being fastened to the bands on these frames. When one pan is depressed by a certain force it twists the framework and we find that by exerting an equal force on the opposite pan, the

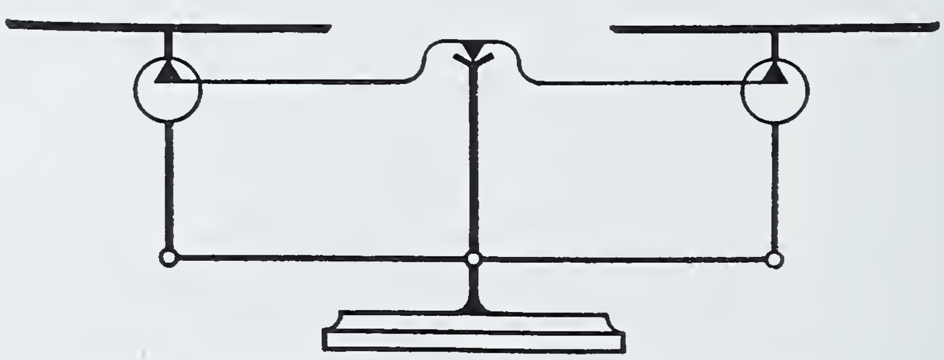

Fig. 6—Diagram of the Torsion Balance Principle.

framework returns to its normal position and the two pans are again in a state of equilibrium. Torsion balances are available for counter use and are made extremely sensitive for prescription use in pharmacies.

PLATE FULCRUM SCALE

The latest principle as applied to the manufacture of scales lies in the use of what is known as the plate fulcrum in which the arms of the scale are fastened together with flexure plates thus doing away with the question of friction and wear which has been the source of so much annoyance and trouble in scales supported on knife edges and bearings. This principle finds practical application at the present time only in the manufacture of large scales, it being developed primarily to fit the need of railroads in weighing freight trains, etc.

Wonders of Weight and Measurement

This brings us to the consideration of some of the wonders of weighing and measuring today. When scales or balances are mentioned the majority of us pass it by recalling probably the scale observed in the delicatessen, candy kitchen or pharmacy, or we think of measuring in terms of inches, pounds, ounces, or gallons. But let us look for a moment at some of the other applications of the subject and we will soon realize that this is truly man's great art. Plato has said that "if from any art you take away that which concerns weighing, measuring and arithmetic, how little is left of that art," and were Plato alive today he probably would not change that statement one bit.

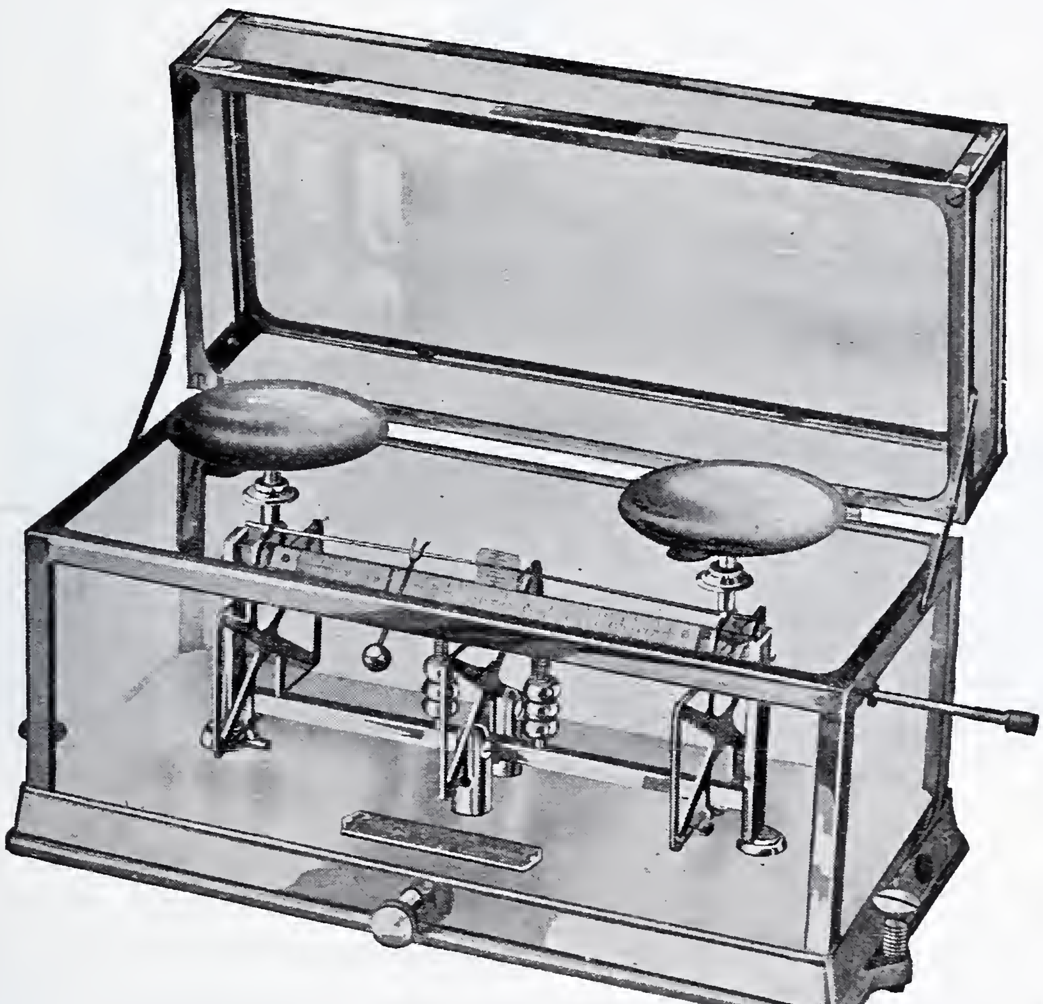

Fig. 7—Fine Torsion Balance for the Prescription Counter.

The development of the sciences and industries has added untold additional units of measurement, too numerous to mention. Our original weight and measure units have extended to the field of the microscope and telescope, and we thus have millimicrons and the still smaller Angstroem unit, of which it requires 254,000,000 to make one inch, used in spectrum analysis for the measurement of light waves. The greatest unit for distance is the "light year," which

is the distance which light will travel in one year or about 6,000,000,000,000 (six million million) miles.

THE COMPUTING SCALE OR MATHEMATICS WIZARD

We might first note the further development in the use of scales and how they are made almost human in their service. We have all probably wondered at one time or another and have frequently heard housewives exclaim over the manner in which a butcher can place a chicken worth forty-three cents a pound on his scale and the moment the scale comes to rest, while you are still trying to read off the number of pounds and ounces, he calls out "two seventy-three," and this is no round figure or bargain price either but the actual cost of 6 pounds 5½ ounces of fowl at 43 cents per pound. It is not the butcher but his scale that is such a mathematics wizard, for we find the scale equipped with a revolving cylinder covered with a paper chart equipped with row after row of figures which are nothing more than muliplication tables. One column indicates prices

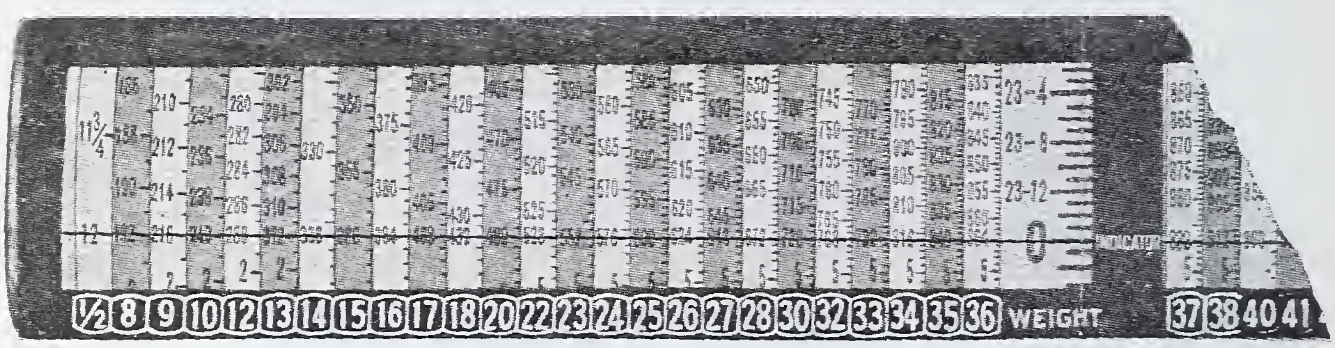

Fig. 8—Chart of a Computing Scale.

for meats selling at 43 cents per pound, other columns those for 42, 43, 44 and so on and likewise the computed price for one pound, two pounds and all the intervening fractions are indicated including the extremes both high and low. As the scale is used the cylinder revolves, comes to rest and, in the case of our chicken, one simply reads off the figures on the line with the 43 cent column and that is all there is to it. No paper and pencil and no errors when you use this mechanical mathematician! We can see now how the use of this principle is easily extended into almost any line, for the chart may be made to conform to the requirements of varied industries. For instance, suppose we were to use it to count nails. The number or size of the nail would replace the price per pound figure above, and the total number of nails weighed would be indicated in place of the computed price of our chicken. Incidentally the use

of scales for counting small objects, for measuring the length of a bolt of cloth or to obtain the number of pints or gallons of liquid in a container is quite marked. One needs but to weigh the lot, and knowing the weight of the unit, it is a simple matter to calculate the total number of such units. Here again many scales are equipped to give these readings direct, similar to the system referred to above or by an ingenious method of using a given number of the items as a unit of weight, the total number being weighed or counted then being indicated on the beam in multiples of this unit.

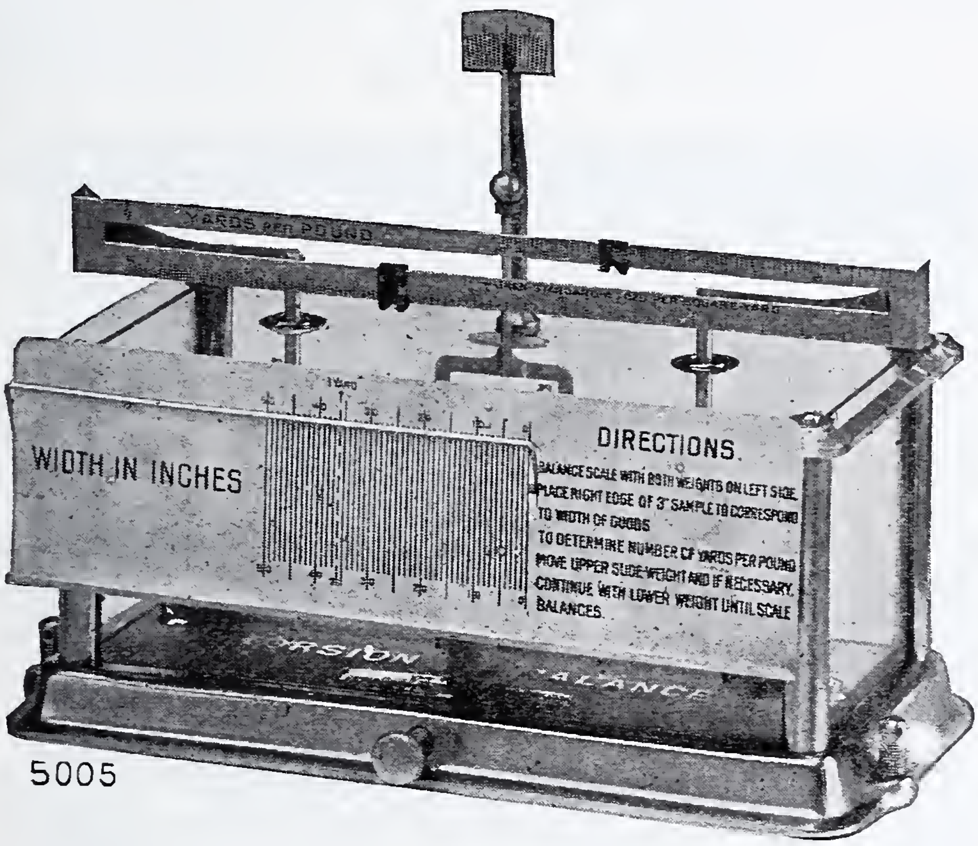

Fig. 9—Cotton Goods Balance Indicating Yards Per Pound.

AUTOMATIC DISCHARGING SCALES

There are also the self discharging scales which automatically weigh a certain amount of material into a container, discharge that container and immediately fill the next. Most of our package goods as sugar, coffee and similar articles are packaged in this manner. And not only is this principle carried out on the small scale but it is also practical in a large way in weighing coal, grain, sand, etc. When a certain weight is reached the source of supply is automatically shut off, the bin is emptied and then the supply chute is again opened. Huge grain scales handle thousands of bushels of grain with a capacity of 500 bushels at each weighing.

The scale in the up-to-date coal yard weighs out five tons of coal to within 3 ounces, prints the weight on a slip of paper and all

without the service of any attendant. Many shipping rooms use this type of service today, weighing all shipments on an automatic recording scale and thus they are able to check any claims of shortage very readily.

CONVEYOR AND SHEET GOODS SCALES

Another type of scale is the one attached to a conveyor whereby the material in passing over belts is automatically weighed and recorded. And again the scale which is attached to machines whereby the weight of continuous sheet goods is controlled during the process of manufacture. By setting the scale at a definite point with a weight pendulum, any variation in the thickness or weight will instantly be recorded and adjustment may be made to the machine as necessary. By this method there is no necessity for stopping the machine to make

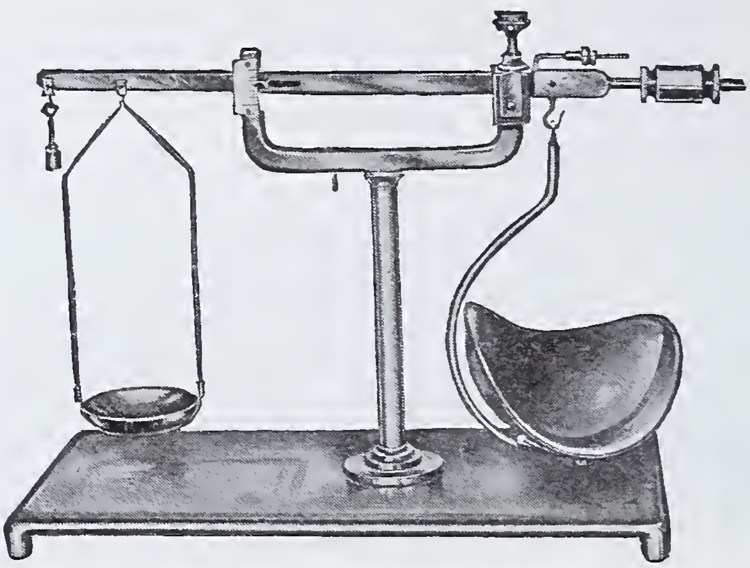

Fig. 10—Counting Balance for Small Items.

a test or to caliper or gauge the material. It is used for such industries as manufacture roofing paper, auto top covers, etc.

MASTER SCALES FOR RAILROADS

Probably one of the most valuable uses of scales is found in the railroad service. When we realize that the entire revenue derived by a railroad from its freight traffic is determined directly by weight, we can get some idea of what this means. One track scale alone on the Pennsylvania Railroad determines freight charges of approximately $50,000,000 annually. Not only do they need small scales for small packages but they also require scales large enough to weigh freight trains. These latter scales are remarkable not only for their size, ranging as high as 100 feet long and of 1,600,000 pounds capacity, but also for the accuracy with which they record the weights of

heavily loaded cars, being sensitive to within 5 pounds. The scales themselves made of huge steel girders are set up underground, while the operating chamber or office is some distance away and elevated to obtain a clear view of the surrounding track. If a freight train is to be weighed it is pushed up a special track until the first car is forced over an artificial hump when it breaks away from the train and coasts down hill and over the track scale at such a uniform rate of speed that there is time to make the necessary reading before it passes off the scale. One car after another follows at stated intervals, each one being weighed in a comparatively short time. One track scale on the Pennsylvania has a record of weighing about 1½ cars every

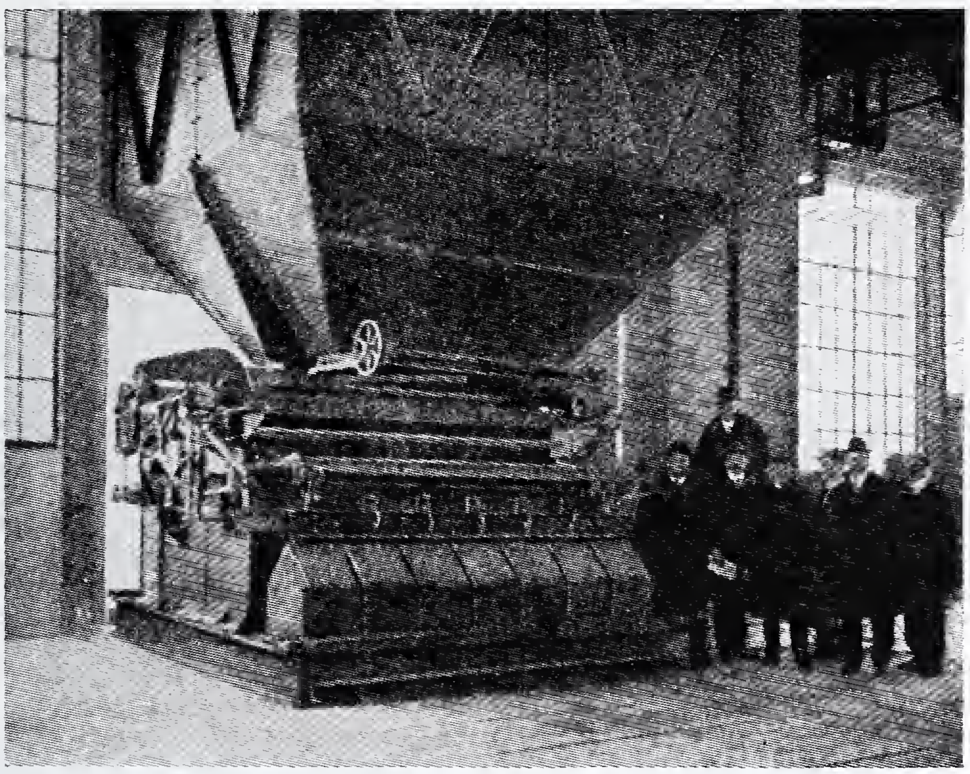

Fig. 11—Huge Grain Scale.

minute for an entire month and has weighed 10 cars in 1 minute and 44 seconds in a test, an average of one car for every 10½ seconds. Compare that with the time it takes you to get your weight on a penny slot machine the next time you get weighed.

ULTRA PRECISION MACHINES FOR WEIGHING AND MEASURING

Nearly every scientific discovery of modern times has been in whole or in part the result of measuring instruments of remarkable refinement, and at the Bureau of Standards at Washington one is able to find many of these pieces of ultra precision in operation. There we find a weighing machine which is so sensitive that even body heat causes it to deviate, and the operator is forced to manipulate its

weights by means of rods from another room, and he reads the indicator with a telescope. The room in which the balance is kept must be kept at uniform temperature, for even ½° rise or fall at the time weighing is being done or even for several hours beforehand would hinder the work.

One balance is used in a vacuum to avoid the buoyant action of air. And so sensitive that it registers the decrease in a piece of metal when moved two inches further from the surface of the earth.

The smallest weights in actual use here are 1/20 milligram or 1/6,000,000 of an ounce. They are made of aluminum, finer than tissue paper and smaller than a pin head. The balance on which they weigh will accurately weigh to within 1/30,000,000 of an ounce.

The standard measures of length are so delicate that their scales can only be read by the aid of a microscope magnifying 50 diameters,

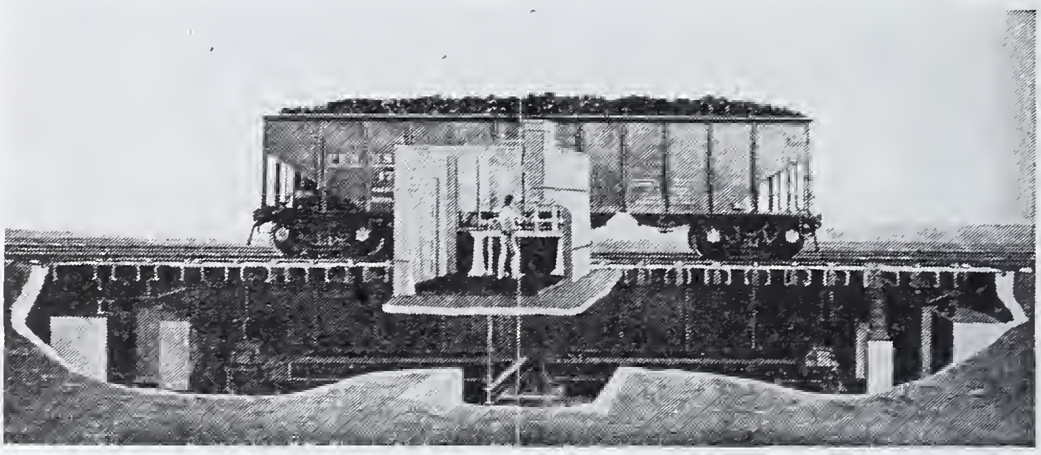

Fig. 12—Railroad Track Scale (Plate-Fulcrum Principle).

and which must be packed in ice when being used, so that they do not change their shape with variation in heat.

Minute measures of length are not determined by the yard stick or even the ocular micrometer but by means of light rays so sensitive that a bar of steel 3 feet by 3½ inches may be bent by placing a calling card upon it, the bending being indicated by the reflected rays of light in the form of concentric rings, such as we see when a stone is thrown into a body of water. As each new circle forms, the bar has been bent 1/100,000 of an inch. This device is known as the interferometer and is used in fine researches, particularly in fixing standards of length and measuring light waves.

Another wonder is a giant testing machine that can pull asunder a 5 inch steel shaft, registering the pull to at least 2,000,000 pounds and immediately afterwards crush an egg shell and register the pressure required with great accuracy.

Another device recently set to work consists of a small instrument which is capable of recording the heat of the stars and far off planets. It will record the heat of a candle 100 miles away.

Again there is the device for measuring liquids which is sensitive to 0.001 cc. or about 1/60 of a drop. This quantity is determined by the weight of mercury necessary to displace the lost liquid.

WEIGHING THE EARTH

Some of you have probably recently noticed the various articles appearing in our papers and magazines on the work recently completed by another bureau scientist, Dr. Paul Heyl. Dr. Heyl, after years of work, has weighed

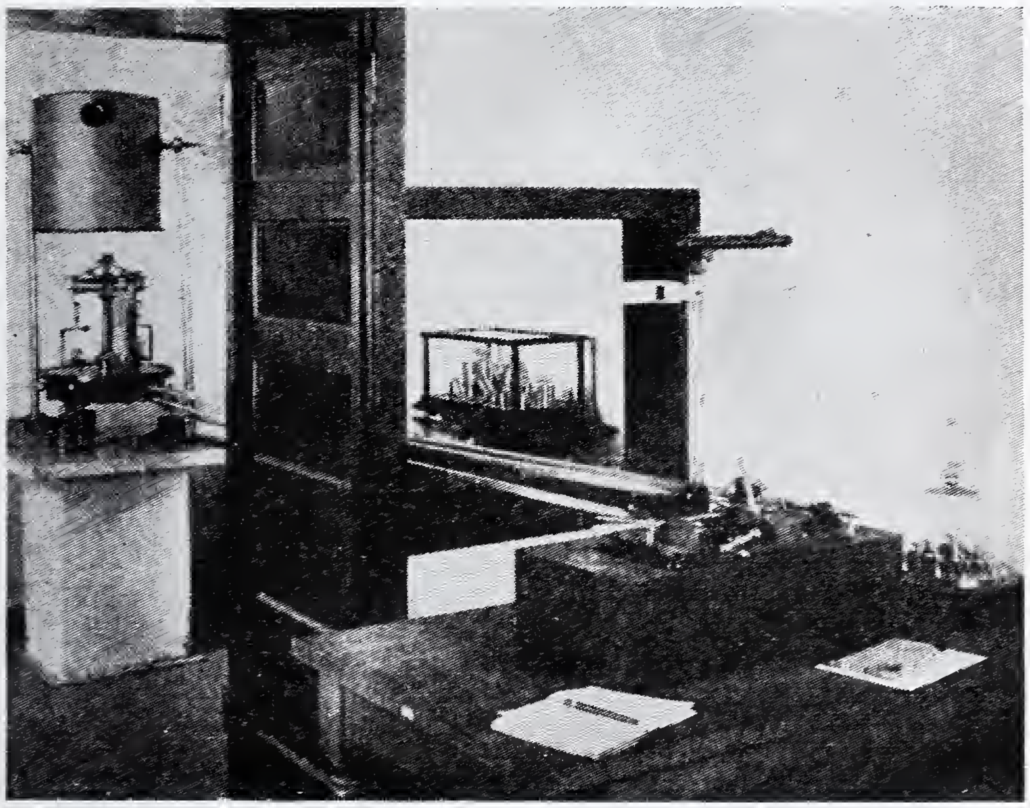

Fig. 13—Precision Balance with Distant Control (U. S. Bureau of Standards).

the earth and finds it to weigh 6,000,000,000,000,000,000,000, (six thousand million million million tons) a sum so large it really means nothing to us. True, he did not weigh it with a balance or scale, but by means of a most delicate instrument which required that the work be done some 35 feet underground, where the temperature is always uniform no matter what the weather outside. The work was based on the attraction of one body for another and was determined by observing through a telescope the swing of a very sensitive pendulum. Day after day figures were copied down as the pendulum swung over its course and from these figures his results were calculated. It is really a check up on what is known as gravitational force and the

results are not primarily of value as far as knowing what the earth actually weighs but are used by scientists in the study of measurements of the sun, moon and stars and also aid in solving the question of the earth's core.

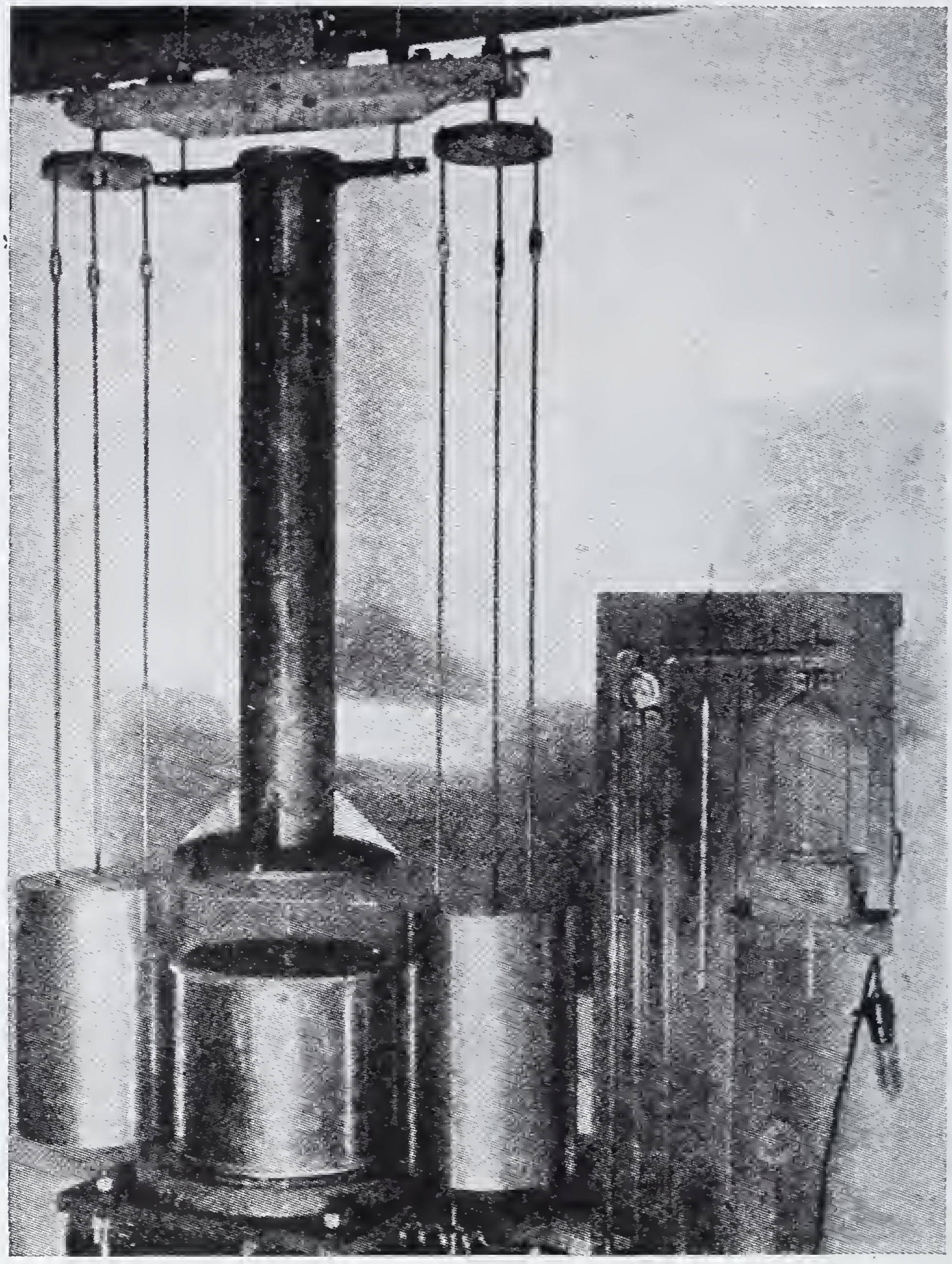

Fig. 14—Torsion Balance Used to Weigh the Earth.

MOLECULES, ATOMS AND ELECTRONS

We often hear the expression after an explosion, of this or that being "blown to atoms," but scientists have now literally blown the atom to atoms and we are not sure even now that there will not be a further explosion. A molecule, or its child the atom, or the grandchild the electron, which is considered as an electrical body charged either negatively or positively, are not measured by the foot rule nor by the telescope, but by their reactions and behavior under certain conditions, together with a series of mathematical calculations. It is said that if a bottle containing about 1 cc. or approximately a quarter

of a teaspoonful of ordinary air, has pierced in it a minute opening so that 100,000,000 molecules (a number nearly equal to the population of the United States) pass out every second, it would take not minutes or hours, nor days, but nearly 9000 years for all the molecules to escape. If you could pile 100,000 atoms on top of one another they would give you an atom sandwich about the thickness of a cigarette paper, while 100,000 negative corpuscles of which the atom is composed would just reach across the diameter of an atom.

With figures such as these and with instruments of precision as remarkable as we have shown them to be, is it any wonder that the art of measurement is called man's master art, and are we not led to wonder to what lands of rare enchantment that art will lead man before he is overcome with the greatness of it all.

If the story of man and his weights and measures as here outlined has given you a new sense of appreciation of this subject, as it has given me in preparing it, I shall feel well repaid, and I trust that when you shop hereafter, the scale or balance used to weigh out your wants, will recall to your mind some of the romance of the family that has made such a name for itself and apparently is still in its youth.

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THE COSMETIC URGE

By Ivor Griffith, P. D., Ph. M.

THIS LECTURE was announced as one which would deal with the historics and hysterics of the art and science of Cosmetics. Had the lecturer contemplated upon his Greek more carefully he might have selected for his subject a topic much more limiting than the Cosmetic Urge.

Ivor Griffith

For even the dictionaries seem to have their own troubles about defining the word Cosmetic. One pronounces it a word borrowed from the Greek (κοσμεω) kosmeo meaning "to adorn" or "to decorate." Another claims its origin to be (κοσμος) kosmos, meaning "harmony" or "order" —and Webster insists that a cosmetic is an agent which "improves on beauty."

Of the group, insofar as the boundaries of this lecture go, the most fitting of the definitions seems to be that which refers to cosmetics as decorating commodities. Certainly there is very little of "harmony" or "order" in much of the result of the cosmetician's handiwork as brought to our notice by his or her overpowdered—overpainted patrons of this day and generation.

THE COSMOPOLITAN SPLURGE

And so far as Webster's definition goes, namely "improving on beauty," we insist that it takes entirely too much for granted—at least in this adorning age, when the milk-and-water cosmetic urge of mid-Victorian days has grown into a fierce cosmopolitan splurge which is not a bit finicky about what it starts out to "improve."

The history and mystery of decorating commodities, therefore, such as paints, powders, pastes, polishes, pyroxylin lacquers, perfumes, pastilles and other paraphernalia, will have our attention during the hour given to us to speak. Obviously too, there must be a preponderance of femininity to the discussion since it is given mostly to the weaker, though not the meeker sex, to suffer or profit at the cosmetician's hands.

COEDUCATIONAL COSMETICS

The rougher, ruder sex need not infer from this however, that it will be immune from certain caustic criticisms which are bound to effervesce during the evening—for one only has to conjure a vision of rows of even shouldered, evil-smelling bottles, on parade at barber shops to realize that the he-man, too, is a pretty good patron of perfume and paste and pooh-bah. And now that the barber shop is a co-educational institute—and the *Police Gazette* has become partly effeminate, both sexes must share a lot of good-natured ridicule.

Let us consider primarily just why the decorative instinct should be so manifest in the female of the human species. Oddly enough it seems the fashion of the animal world for the male to be vastly more attractive—more striking in appearance than the female. Witness the contrast between the proud-strutting rooster and the timid brown hen; between the majestic lion, beau brummel of tropic plains and his homely, ill-tempered old shrew of a wife; between the bull moose of the backwoods, resplendent in his artistry—lordly in poise—with his widespread branched antlers towering nigh to the tree-tops, and his dreary, weary looking companion cow, whose antlers are ingrown and who like an overgrown mule, affords a tragic contrast to her stunning husband.

And with some evolutional exceptions, the general rule of the animal world seems squarely to be that the husband of the species is more lovely than the wife. But let us not overlook the cosmetic moral in the thought that, in spite of her unloveliness, Leo loves his Lena with a life-long devotion—and the antlered moose will lose his life rather than let a rival steal his homely mate.

Still there is no telling how much more attractive the lioness would be, were her pouting lips done up in mercurochrome—her eyes ensparkled with belladonna—her eyebrows black with sulphide of antimony—and her furry cheeks touched up with paint and powder, fresh from the Jungle Beauty Parlors.

I leave it to your imaginations to wonder what Leo might say or do, did he come home from work one African eve to find his mate so decorated.

The Kingdom of Man has had its like experiences—and many a lion of the genus *Homo,* has come from work one American eve to find his mate so decorated.

And what did he say?

Well, just what the lion said—*Nothing!!*

It would be hazardous in an audience so preponderantly feminine, for a mere male to opinionate adversely as to the artistic superiority of the one sex over the other—insofar as the genus *Homo* is concerned.

A sort of a happy compromise might be reached if one agreed that in fundamental beauty of line and form there is little to choose between the idealized David of Michael Angelo and the similarly idealized Venus de Milo—except perhaps that the latter is not "all there." But these are verily idealized—and are unfair to compare.

And since beauty has an unencompassed definition and within its nuances of meanings holds to some, more importance internally than externally—the kind of beauty which is not skin deep—it were better for us to omit comparisons except those which are purely physical and ornamental.

Going back to the dawn of that epochal day—when a queer, hairy pair of creatures emerged from over the hills of chaos and followed the sun to its setting—what a vision of ugliness we see—judged by today's opinions.

From skulls deep hidden by the sands of time and upturned by greedy minded grandchildren, we fabricate the face and form of these, our long-gone kin.

And what faces and forms they are—The Heidelberg, Piltdown, Cro-Magnon and Java—what a queer quartette they make. Yet they were our ancestors—ugly and unrefined.

Such differences there may have existed then between the sexes are matters of pure conjecture. Yet I venture the biologic guess that in accord with the rest of her animal plans, Nature had given to early man a physical design more attractive than that of his whining mate.

Since then, however, Dame Nature has exercised most profoundly that feminine prerogative of changing her mind—for Nature has conspired with Art to effect such an evolutional differentiation between the sexes that Woman today reigns supreme as the most beatutiful creature of the universe.

I do not exactly know where the days of Adam and Eve belong in the evolutional time table—yet we must concede that even then, the female had improved a lot, at least in physical attractiveness, that is if the interpretation of artists is in any way to be relied upon.

Burns—the *one* generous Scotch poet—was quite an authority on women, and this is how he sang of Nature's creation of Eve—after Adam.

"Her 'prentice hand She tried on Man
And then she made the lasses O!"

It is not clear whether the O! is an expression of content or of contempt.

Strangely enough, in those early chapters of Genesis—after the recital of the creation of the cattle—the whales—the birds—and other animals, in each instance the sonorous claim is made that

"God saw that it was good."

But no such claim is made when the first anæsthesia, formed from a rib of old Adam's, his apple-tempted partner. Yet even the staid scripture suggests that Eve was gentle, sweeter and more beautiful by far than her mud-made comrade.

However, it is a long time since Adam and Eve and it is very evident today that evolution has so changed matters from a decorative-ornamental standpoint that the current Cleopatra—far surpasses her Antony in physical attractiveness.

EINSTEIN AND BEAUTY

Of course our judgment of beauty is largely a matter of relativity—and much prejudiced within a period or people. Thus the modern Chestnut Street flapper—perhaps to flipper eyes a marvel of grace and beauty—yet would in Borneo or Madagascar be slaughtered out of sheer charity.

The customs of a race or a time are totally ridiculous to another people or period. In South America women of *certain* tribes file their teeth or dye them dark the more readily to enmesh their victims—who just love teeth that look like the cogs of a fly-wheel. That is their idea of beauty. In North America women of *uncertain* minds bleach their hair an anemic catarrhal yellow just because a scenario writer once wrote that "gentlemen prefer blondes." And that is another idea of beauty.

Speaking of operations—who remembers the custom of two or three decades ago when drilling holes in young ladies ears was quite as popular as tonsil snaring and adenoid baiting is today? Indeed the young lady whose ear lobes were unpunctured was as much a *rara avis* is those days as a bobless beauty is today.

MID-VICTORIAN ATTRACTION ATROCITIES

And let us not forget that boring holes in young ladies' ears so that they might more serenely carry the half pound plummets or sinkers called ear-rings —was not the only attraction-atrocity performed in those demure

days. Oh no! Consider the agonizing architecture of milady of those times.

Possibly the most prevalent pathology of the architecture of the late Victorian period to which we now refer, was a tendency to elephantiasis. Everything had to loom large. Walnut bureaus were built like battleships, cottages were proportioned like cathedrals, and cloaks and suits like tents or hangars.

Cosmetically, milady left her face as she found it—though the rashest might venture to sprinkle a little lavender water over her velveteen train. Costumically, however, she dressed in voluminous clothes and acres of textiles were spent on her garments. Many a dressmaking establishment to-day, carries less goods on the shelf than a lady of the nauseating nineties would carry on her self.

Self restraint is splendid but the self inflicted restraint of whalebone harnesses, of silk lined strait jackets, of corsets that made wrists out of waists, of collars that only giraffes might wear in comfort, these were the penalties of attractiveness in those unhealthy days.

There comes Madam down High Street this very minute. Picture her—a veritable street cleaning department—yards of homespun trailing in the dust, gathering burnt matches, dead leaves and cigar stumps and all the wind swept debris of courts and alleys. She approaches a Colonial doorway—ample in its proportions and for very ample reasons. Before ascending the marble steps she manipulates a cord and pulley contraption whereby her hoop-skirt inclines a bit so as to permit freer exercise for her climbing ambitions.

Once in the capacious house she selects a capacious chair—and does she dig deep in a beaded handbag and out of its abysmal depths fetch a first aid outfit to powder her nose and lacquer her lips—Crime of crimes—No! Or does she unearth a shiny thing-a-ma-bob and find the spirit willing but the flash weak—and then borrow a match to inflame her Fatima? Sin of Sins—No! But the sins of priming a cigarette and primping one's person with paint and powder as now practiced are not half as bad as the unhygienic sins committed then in the name of body cast and costume.

But enough for the while—sufficient to state that the false modesty and prudishness that largely dictated dependence on unhygienic and unhealthy pads and bustles and rats and collars and corsets has been displaced by a common sense dictation in the matter of woman's dress.

It is to the eternal credit of the weaker sex that it has through its own efforts emancipated itself from the silly chains and whale-bones which had bound it secure for ages untold. Partly through a better regard for physical hygiene and an untrammelled functioning of natural processes—and partly through the agency of artifices of sensible dress and jewels and cosmetics—the attractive physical presence of the modern woman is a perfectly natural development.

The essence of woman is beauty—in all that the word implies—in all that it breathes—refinement, delicacy, elegance, grace, romance—and it is no crime to retain this essence—or to glorify it to the zenith of its possibilities. Only remember that I insist that it be done and not over done.

Richard Le Gallienne, whose very name suggests a gallant poet, charmingly paints with colorful words the vision I too can see, but am too clumsy of touch to portray. Here is the picture.

"Nature unadorned, lovely as she may be, seldom makes the most of herself, and her handmaiden art can teach her many things that do not necessarily artificialize her, but, on the contrary, develop and accent her naturalness. The lily of the field may not need painting, but the human lily is usually improved by sweet-smelling powder and a touch of rouge. As man's first duty to woman is his strength, so woman's first duty to man is her beauty. It remains, as of old, his inspiration and his reward. It is also her first duty to herself, for self-expression is the law of all healthy organisms. The meaning of woman is—beauty, and all that beauty implies, all that emanates from it: delicacy, elegance, romance, and the atmosphere that exhales from these attributes. The achievement of this need not detract from a woman's work-a-day qualities, her goodness, her helpfulness, or her intelligence. On the contrary, these qualities all gain by association with charm.

"It is curious to observe that the widespread renaissance of feminine æsthetics has come side by side with her vigorous entry into that hard work of the world which had previously been regarded as the exclusive province of man. The old idea that the cultivation of a woman's brain meant a neglect of her beauty has been exploded, as the most cursory glance into a modern office, or even factory, is enough to prove. In entering man's world, woman, far from abandoning her own, has emphasized it, and whether she is a lawyer, doctor, or stenographer, she is very evidently more a woman than ever. I do not think it a masculine illusion, but it seems to me that the

world can never have been so full of beautiful women, and the reason is that never before has woman, en masse, willed so whole-heartedly to be beautiful.

"For generations she has been a mere amateur of herself. Now she has become an artist—not to make of herself something that she is not, but to bring out what she is, to show herself in her completely expressed naturalness, as nature meant her to be, but sometimes failed in achieving. When Nature has not done her part, who shall blame a woman for striving to make up the deficiency? And by means of feminine æsthetics, a woman less endowed with natural beauty than some others can contrive to give an impression of beauty to 'the eye of the beholder' which is surely a gain all around."

Thus it is maintained today that there is no longer an excuse for physical ugliness except perhaps, that which is congenital or accidental. The sensible adornments of attire—the ease with which personal hygiene may have attention—and the limitless array of talent and tools dedicated to the care of external appearance—leaves no excuse for lack of outward grace and elegance.

DOING AND OVER-DOING

Only the great danger comes as ever by over-indulgence and intemperance—and if there is any one phase of external decoration which is today overdone it is in the field over which I elected to speak this evening—namely with respect to cosmetics.

Nor is overdoing or overmaking up the only sin committed in the name of Cosmetics, for this field of personal adornment is one that lends itself very easily to the wiles of the quack and the crook. The percentages of Nature are so stable that we might call them physical constants, and that a "sucker is born every minute and a crook every hour" is a plan against which it is idle to protest. In other words, for every sixty of these gullibles it is in the order of things that a crook or a quack is born—and this proportion has prevailed it seems for many and many a day.

Kittens take two weeks to open their little eyes—but there are humans whose mental eyes seem closed long after their kindergarten days. And it is these human kittens who largely furnish the force and fashion the farce of the great cosmetic splurge. For they are the believing kind who hearken to the claims of every noisy quack—and who fall easy prey to the wiles of every occurring crook. They form the undiminishing multitude that still believes in the creative

functions of hair tonics—in the face lifting, wrinkle erasing ability of creams—in one night bunion banishers, and in two-day chest or hip removers.

THE COSMETIC SCOURGE

Open the advertising pages of some of the Beauty or Stage or Physical Culture gagazines and behold the display of deftly baited tackle waiting for the poor fish to swim by. Then gaze with awe at the "befores" and "afters" on parade. There is exhibit A—a line picture of Mr. Joseph

Testimonial of Mr Joseph Goofus, Haddonfield. N.G.

Goofus, of Haddonfield, N. G., twenty minutes before he sprinkled upon his simonized nap-less scalp a swig or so of someone's hair oil. And there he is, according to the artist, just about twenty minutes afterward. Look at his cranial upholstery now. Shades of the curl-clipping Delilah.

And here is exhibit B—and this *is* an exhibit. Both figures are or were, do or did represent a Mrs. Henrietta Bulkie, prior to and immediately thereafter—namely, the occasion of consuming in proper sequence five boxfuls of Dr. Fulsom's reducing Valves.

WATCHFUL WEIGHTING

Party of the first part in bold face outline is Mrs. Henrietta Bulkie on her forty-fourth birthday. She weighed ten pounds when she was born—and every birthday seems to have brought ten more. Party of the second part marked in dotted lines is the same Mrs. Henrietta Bulkie two weeks after her forty-fourth birthday, reduced to the least common denominator—the interval in between having been occupied by said lady in the important business of eating five pounds of birthday candy and five boxes of Fulsom's Flesh Paring Pellets. Unlike the customary fairy tale however, this one does not indicate that Mrs. Henrietta Bulkie lived happily ever afterwards—that is, assuming that she ever lived at all.

Shylock, with his paltry pound of anthropic tissue was a piker compared to Dr. Fulsom who figures his flesh only on a quantity basis.

But it was not our intention at this point to tarry too long with the falsities and frauds of the cosmetic quack, for we meet with him later on in our talk, but so as to prove that "it was always thus," let me quote this formula given to an age old Celtic hair restorer:

> "With mice fill an earthen pipkin, close the mouth with clay and let it be buried beneath the hearth-stone, but so as the fire's too great heat reach it not. So be it for one year, at the end of which take out whatever may be there. For baldness it is great. But it is urgent that whoever shall handle it have a glove on his hand, lest at his fingers ends the hair come sprouting forth."

PAINTING THE LILY

To gild refined gold—to paint the lily, to sprinkle perfume on mignonette, have long been held to ridicule. The fact that Michael Angelo and Tintoretto and Gainsborough and Reynolds could for all their skill—never do justice to human countenance, the mirror of the soul, has been quoted to gainsay and question the possibility that the casual application of a daub of rouge or a cloud of powder might improve the human countenance.

To such an argument we venture the counter statement that many a great masterpiece of portraiture exists which is a vast improvement upon its model, and that much burnishing and fertilizing and sprinkling of perfume seems necessary upon occasion to redeem a tarnished gold—or to restore a languid lily—or to cover the tawdry tell-tale scent of a decaying mignonette. And if Webster missed it with his "definition" of cosmetics as "improving on beauty" I still

feel that they have their place in "inciting to beauty" and in "beclouding the blemishes." In this connection, the old colonel had the right idea, no doubt. Thus a brusque old colonel, newly married, whose wife had just returned from a beauty parlor, greeted her with this welcome: "For pity's sake go and get all that stuff off your face." When she returned, having obeyed, he shouted, "Good heavens, go and get it put on again."

It is not an easy task ever to draw the line between the intolerance of purists and puritans and the intemperance of fools and pharisees. I quote this silly 1928 tirade against the use of cosmetics and other body adornments. It originates in Guthrie, Oklahoma—out there in the great open spaces where all men are reformers and women have fifteen minutes off on Sunday.

Dress Reform Pledge

If averse to signing this, see 2 Corinthians 13:5.

I promise to abstain from:

Short sleeves—Less than ¾ length
Short skirt—Above the shoe tops
Unnecessarily bright apparel
Attractive head attire
Dressing the hair and the use of Cosmetics.

Just as ridiculous however, when overdone, is the custom, which seemingly is on the increase, whereby young women—kalsomine, lacquer, enamel, veneer, bake, parboil, porcelain finish, shellac and electro-plate their faces with chemicals and corrosives fit only for barns, radiators and board fences.

The other day I saw a futuristic picture of Franklin Field after the ball game was over, and I said to the artist—"What are those fuzzy caterpillars streaming out of those red wren houses." And he looked sympathetically at me and pronounced them as young men of means wrapped up in raccoon coats. But I had no need to ask him what the accompanying fusiform vermilion streams were, for I recognized them at once as the mercurochromed obtruding lips of current Cleopatras.

THE GOSPEL OF "JUST ENOUGH"

If only the "toomuchness" could be left out of our living, in many directions, how much longer and more lovely life would be. How much better it were could we all grow closer to the gospel of "just enough."

But on with our story—or shall I say with history—for the use or abuse of cosmetics is not by any means a recent disease.

Women of ancient Egypt over three or four thousand years ago employed all sorts of paints and cosmetics to improve their appearances and it is said that their beauty parlors were often as elaborate as the fashionable ones of today. Of course they catered only to the classes—for the masses still belonged to the great unwashed and unrefined.

The cosmetic ointments unearthed in Tut-ankh-amen's gaudy vault, the long lingering perfumes, the paints and pastes and powder used by these sweet sisters of the Nile, were not a great deal different from those dispensed today. There were finely powdered ochres to tint the lips and cheeks. The eyebrows and eyelids too received their stygian homage—for Kohl, a fine powder of resin soot or of sulphide of antimony was applied to the region of dark Egyptian eyes in order to enhance their goo-goo gaudiness.

ALCOHOL—ONCE A COSMETIC

It is interesting to note here that our word alcohol finds its origin in this eye painting commodity—for it is the Arab Al-Kohl—or the finely divided matter—that gave us this prohibited word. Since that early day however, "Al-kohl" has increased its tinting territory. For today it might be considered fully as responsible for red noses as it is for blackened eyes, and as it was for blackened eyebrows and eyelids.

Henna, now used to hide the silver threads among the gold, was employed by Egyptian belles to stain their hands and finger nails, a practice said to have been indulged in by maids of Athens too, and to have given rise to that Greek metaphor—"Rosy fingered Aurora."

The heyday of cosmetics in Egypt was no doubt the period of Cleopatra's long reign—whose rare meeting with Antony on the banks of the Cydnus is immortalized by Plutarch and plagiarized by the sweet Bard of Avon. It was with lavish use of every available perfume and paint and artifice that this pearl-dissolving queen found such an easy Mark in Antony, for contemporary writers tell us that she was much easier to look at when leaving her beauty parlors than when she naturally walked in.

SEMITIC COSMETICS

That the children of Israel in captivity learned much of the esthetic tricks of Pharaoh's daughters, is indicated in their cosmetic indulgences when once they went into the business of government on their own account. Indeed

the altar of incense erected on Holy Command by Moses, suggests an early Semitic allegiance to perfume and kindred cosmetics.

"Take unto thee sweet spices, stacte and onycha, and galbanum; these sweet spices with pure frankincense; of each shall be a like weight, and thou shalt make it a perfume, a confection after the art of the apothecary, tempered together pure and holy." So runs the command in Exodus.

It will not be sacrilege to aver that Moses must have had nearly as difficult a job converting this formula to perfume as he had changing the stick to a snake. For in the light of present interpretation the formula seems to adapt itself better to a fine spar varnish than to a heavenly scent.

Yet Moses thought so much of it that he restricted its use only to holy purposes—and in an amendment to his decimal decree indicates how incensed he would be were this sacred incense used for private purposes.

"Whosoever shall make like unto that, to smell thereto, shall even be cut off from his people."

Which suggests too that substitution and "something just as good" are not as modern as we thought they were.

The Babylonian and Assyrian women, too, were great exterior decorators. They, too, circumscribed their eyes with black of antimony (stibium) and not only tinted their eyelids and eyebrows but actually filled the corners of their eyes with this ethiopian coal dust.

As did Roman matrons in later days, they too enamelled their faces with white lead and scrubbed their teeth with ground up lava.

Perfumes of a sort, it is said, were generously indulged in by Babylonian beauties, for long before the reign of Colgate and Hudnut, necessity had taught them the redeeming obscuring offices of good substantial perfume. Those were the soapless days when perfumes were valued according to their covering qualities or strength and not according to their subtlety or mildness.

"If you don't use our soap, for heaven's sake use our perfume" is a modern aphorism but it is more of a truism than an aphorism insofar as the good old days were concerned.

Jezebel, whose name has rung down the centuries as synonymous with female perversity, painted her face and bobbed her hair just a few minutes before she fulfilled Elijah's prediction, and literally, went to the dogs.

In the halcyon days of Greece and Rome the cosmetic art achieved to very high eminences. Abundant records in prose and poetry remain to describe the Greek and Roman excesses in dress and style and paint and powder. Juvenal the Roman satirist refers to the boudoir of an emperor's mistress as an elaborate establishment where perfumes, and oils and spices garnered from every corner of empire served to adorn the Roman beauty.

"She hurries all her handmaids to their task
Her hair alone will twenty dressers task
Psecas, their chief, with neck and shoulders bare,
Trembling considers every sacred hair."

Generally the hair of Romans was a jet black, and blondes were naturally rare and as naturally envied. All sorts of tricks were employed to bleach the hair—one of the commonest being the "mattiac balls" of rancid goat fat and ashes of oak. Then, too, there was that very delicatessen bleach made of leeches steeped in vinegar until they smelled badly.

Ovid, that garrulous old maid of an author, refers to the iniquity and inaninity of these unnatural hair bleaches in one of his metamorphic songs, in a very "I told you so" manner.

"Long since I warned you not to use that bleaching lye
Now there is left no single curl to dye."

Indeed the keen-cutting tongue of Martial, another old shrew of a Roman poet, alludes most sarcastically to the blond wigs affected by the envious brunettes of the Tiberian boulevards.

"The golden hair that Galla wears
Is hers—but who'd have thought it.
She swears it's hers—and true she swears
For I know where she bought it."

Now lest we be indicted for too much discursive femininity—let a Greek poet tell us in a lame translation that loses much of its Athenian finesse, just how a young dandy of Athens dressed up. The first line of the verse, is fortunately, redeemed by the lines that follow:

"He seldom bathes
But in a gilded tub, and steeps his feet
And legs in rich Egyptian unguents.
His neck and chest he rubs with ripe palm oil

And both his arms with sweet extract of mint.
His eyebrows and his hair with marjoram,
His knees and face with essence of wild thyme."
(Antiphanes.)

To which we remark that the Greek dandy, according to our olfactory impressions must have presented an anatomic ensemble that smelled on the odometric scale—somewhere in between vegetable soup and soap liniment.

That there were puritans in Rome too, is evidenced by Martial's address to Polla, a famous Roman matron whose sixtieth birthday was spent according to Pliny in a "poultice of honey and wine lees with bulbs of narcissus ground fine," this in order to conceal the creeping crowsfeet of time's unerring scars.

Sings Martial quaintly and understandingly—

"Leave off thy paint, perfume and childish dress,
And Nature's aging honestly confess,
Two fold we see those faults which art would mend,
Plain, downright homeliness would less offend."

Juvenal too, dislikes these rejuvenating poultices and mud packs, for he states that the Roman husband rarely saw his wife's face at home, but only when she appeared in public. Referring to Poppæa, Nero's wife, who used to bathe in asses milk, and who when banished from Rome by her roaming Romeo of a spouse to make room for a more amiable amour, took with her a train of fifty of these cross but cosmetic animals—Juvenal sings:

"The crust removed her cheeks as smooth as silk
Are polished with a wash of asses milk,
And should she to the North be sent
A train of these attend her banishment."

Before leaving Rome let me quote a Roman formula for a face cream which seems to me not unlike recipes I have seen in my good wife's cook book for Buck's County griddle cakes.

"Take of Libyan barley husked and scoured two pounds, no less—and the same of powdered jack beans. Mix with them ten fresh hen's eggs. Dry in the sun for a day and a half. Then have them ground and add the sixth of a pound of calcined antlers. Gather of narcissus in early spring, before the bloom disrupts the bulb, take twelve such bulbs and pound them well in a mortar. To them add

all of the powders above and then two ounces of gum of Araby, as much Tuscan seed and eighteen ounces of clover honey gathered at dusk, when the flavor is best. Beat them all to a very smooth fair paste. Yet smoother and fairer will be the face and hands of every woman who anoints herself with this."

COSMETICS AND THE FALL OF ROME

Just what cosmetics had to do with the decline and fall of the Roman Empire I hesitate to state, yet it is said that in these last luxurious days of the decomposing Empire their use reached such demoralizing proportions that the consuls, Lucinus Crassus and Caesar, published a law forbidding the use of all "exotics" or toilet accessories. Yet as in the case of Solon's edict delivered from the crest of the Acropolis in Athens, it was no better observed.

Odd indeed are the ideas and ideals of epochs and peoples as we judge them from our viewpoints.

Count Sonnini in his Travels in Upper and Lower Egypt states that there is no part of the world where the women pay a more rigid attention to cleanliness than in the Oriental countries. Nowhere in the world can the women assist nature in arresting the ravages of time as in the circles of Cathay. But listen to this Oriental recipe for eye paint.

"Remove the inside of a lemon, fill it up with plumbago and burnt copper, and place it on the fire until it becomes carbonized; then pound it in a mortar, adding coral, sandal wool, pearls and ambergris, and the wing of a bat, the whole having been previously burnt to a cinder and moistened while hot with rose-water."

There is a complexion powder called Batika, which is used in all harems for whitening the skin. It is made in the following manner: There are pounded together in a mortar some cowrie shells, borax, rice, white marble, tomato, lemons, eggs, and helbas. They are mixed with meal of beans, chick peas, and lentils and the whole placed inside a melon mixing with it its pulp and seeds. It is now exposed to the sun until dried and then it is reduced to a fine powder.

HAIR DYES—HAIR DIES

A famous hair dye is composed of nut galls fried in palm oil and rolled in salt, to which is added cloves, burnt copper, minium, aromatic herbs, pomegranate flowers, gum arabic, litharge, and henna. The whole of these ingredients are pulverized and incorporated in the oil used for frying the nuts. This gives a jet black color.

The Orientals also use a perfumed almond paste, called hemsia, as a substitute for soap; a tooth powder called souek, made from the bark of a walnut tree and powdered bone; a depilatory called "termentina" composed of thickened turpentine, and similar to our depilatory waxes, and lastly a fine white cream of benzoin and jasmine pomade.

In China perfumes are not exceedingly popular. Musk—that long lasting animal odor—is their favorite perfume. Sandal wood, patchouly, soya and asafoetida complete the list. Neither is soap much used in China, in spite of its floating propensities, but the Chinese belles are not averse to cosmetics. At night they smear their faces with tea-oil and rice flour, and carefully remove it in the morning. Then they use a white powder, carmine on the cheeks, lips, nostrils, and tip of the tongue, and all topped off with a sprinkle of rice powder to bloom and soften the harshness of the colors.

BELLADONNA

So through the ages might one find volumes upon volumes of quaint cosmetic lore—but we must hurry on. However, there are one or two points of especial interest to note in passing by.

For instance there is the famous herb of Atropa—first cousin to spud and tomato, whose very name breathes romance and beauty. For belladonna, whence eye drops come, gets its name Bella donna or "sweet lady" from the fact that Italian belles enlarged the pupils of their pretty eyes with this all-potent herb.

And there is court plaster, so named because ladies of King Charles' court esteemed it very fashionable to plaster their faces with trim patches of this sticky black fabric. Evelyn, the second best diarist, remarks quite naively that "painting and similar tricks of the toilet did not become established among *respectable* women before the spring of 1654."

Sinisterly enough this was just four years after a bill had been introduced into the House of Commons by the Puritan party for the suppression of "the vice of painting, wearing black patches and the immodest dress of women."

We might have tarried, were it not for press of time, a little in Venice and Florence, where prosperity as ever revived the cosmetic arts and out of whose history came such romantic names as Santa Maria Novella, the monastery where the first cosmetic laboratory opened its doors with monks as skilled perfumers.

And there is Frangipanni, who accompanied Columbus on his trip to see America first, whose famous perfume yet carries his name to this day. Diana of Poitiers, Cagliostro, Richelieu, Madame du Barry and Pompadour, Marie Antoinette and Madame Tallion's bath of crushed strawberries. Good Queen Bess, whose still-room was only cosmetically inclined, Isabella of Spain and Chypre—Napoleon's pet smells and his quarterly perfume bills of a thousand francs. All these historic names might keep us busy with their romance and make us forget that we have yet to talk of the present—whose cosmetic contraptions are so commonized that not kings and queens and cardinals alone have access to their wiles, but all who wish to use and abuse them.

LO—THE PURE INDIAN

And here we are at last away from other times and other climes, and back to our own domain and day. And certainly with no nation had the cosmetic urge a better start than with us of North America. For long before the lichens and weeds around the Plymouth rock were disturbed by the hob-nailed shoes of Christian vagabonds, a race roamed our land whose decorative instincts were most intimate and personal. For Lo the Poor Indian was rich in vanity long before the paleface came.

No damsel or dowager of old ever spent more time with her toilet than a Sioux or Crow getting ready for a trip to his sweetheart's tent, or to the hunt for man or beast. One is not surprised, then, that with such a fine start in the business of feathers and flooey and finery, the cosmetic urge should have found this continent such an easy place to progress.

But times change, and there is an evolution to every living thought and thing. Through all the ages up to the present we have followed the trail of the cosmetic urge—and have noted its sporadic, spasmodic yet constant development. From the lotus perfumed, ochre tinted lip salve of Antony's beloved to the phosphorescent mercurochromed, kiss proof lipstick of the current Cleopatra, is a long, long way. In between times, of course, there were those drab days when milady was pleased to leave her face and her figure as she found them—but always these were only temporary setbacks.

And never was a time when the urge was as all-consuming, all-embracing and powerful as it is today. Picture the modern flapper —be it shop girl or lawyer, aviatrix or mill-doll, doctor or nurse, dowager or damsel, mother of ten or school girl of ten. There she

is with a minimum of clothing in between the head and the heels, and avid for cosmetic attention.

CURRENT COSMETICS

Above the neck the upkeep is especially high. For with the bob, the marcel, the shingle, the permanent, the neck shave and ear trim, the cost of the hair keep is in inverse proportion to its scarcity. And what with paint and lipstick, mascara and eyebrow enamel, the face value comes high.

Below the knees, depilatories and veils for varicose veins—corn solvents and bunion and blemish banishers—and not to forget the sinuous stockings of scroopy silk and slippers of satin and snakeskin. No such young or old lady today minds little things like quinsy, pleurisy, pneumonia, sinusitis, coryza, or even early death so long as her outfit is *ritzy* and attractive.

And here at last is the truth about how the fair sex gets that way: More than half of all American women—55 out of 100, to be exact—use rouge.

Seventy-one in 100 use perfume.
Approximately 90 in 100 use face powder.
Seventy-three in 100 use toilet water.
But only 15 in 100 go in for lipstick.

These are the figures reached by a survey conducted by the *Milwaukee Sentinel.*

But for all that, the average woman pays only $50 a year for her perfume, paint, powder and primping which is a little less altogether than the $60 which the average smoker passes over the tobacco counter annually.

Of course if she wishes to go in for exclusive effects in exterior decoration she can spend as much as $27.50 an ounce for the most expensive perfume and proportionately as much for other toilet aids. But on the other hand she can get perfume for 50 cents an ounce—and the average price is but $1.86.

WHAT PRICE BEAUTY?

However, cosmetics and their allied aids to beauty make one of the greatest factors in the business of the modern drug and department stores. The greatest toilet goods center in the world, located in a New York department store, employs forty-nine clerks, occupies an area of 15,000 square feet of floor space, and sells $3,000,000 worth of beauty accessories annually!

The fascinating flapper, demure young matron or desperate dowager who really takes her beauty artifices seriously can spend an afternoon trying to decide what powder to buy in this half-acre of cosmetics. Counting shades, scents, sizes, brands and shapes there are no fewer than 1300 kinds.

The Surge of the Urge!
or
The Splurge of the Scourge?
(A modified Liberty cartoon)

And powder is only an item. There are more than 1200 kinds of perfume. Cold creams number 600, and rouges, ranging from carmine to near-yellow, make up an assortment of 347 items.

During a lecture on cosmetics it will not be amiss to discuss figures—statistically as it were—and so here are some data compiled

by the Bureau of the Census, Department of Commerce, to indicate the immense output of perfumes, cosmetics and toilet preparations in the United States during 1927. That their manufacture is on the increase is clear by comparison with the preceding year, when the output was smaller by twelve per cent. Here they are:

Dentifrices	$30,624,000
Creams	29,978,000
Rouges	11,394,000
Face powders	20,531,000
Talcum powders	8,033,000
Other toilet powders	3,148,000
Perfumes	15,275,000
Toilet waters	8,441,000
Hair tonics	11,438,000
Hair dyes	3,124,000
Shampoos	3,819,000
Depilatories	1,071,000
Other toilet preparations	30,215,000
Total	$177,091,000

Three thousand miles of lipstick, enough to reach from New York to Reno, are used each year by the women of America between the years of 15 and 75, according to a recent bulletin issued by an advertising agency. They based the estimate conservatively on two lipsticks per annum per person.

Also our fair sex uses approximately 375,000,000 boxes of face-powder which allows slightly over a pound to each individual, and some 240,000,000 rouge compacts, not including the liquid and paste rouges.

These statistics show that the average woman spends $50 a year on cosmetics and beauty culture, striking a medium between the practically extinct "just soap and water" advocates, and the constantly increasing number who make a practice of regular professional beauty treatments.

Of this $50, one-sixth is spent for face powder and rouge; one-sixth for creams; one-sixth for perfumes, toilet water, talc and other toilet powders; one-sixth for dentifrices; one-sixth for hair tonics, shampoos, and—sh-h—hair dyes; and the remaining sixth for miscellaneous preparations and for treatments.

Two billion dollars is the amount of money spent annually for cosmetics and beauty treatments, by American women, according to another authority.

Research on the theatrical stage and in society in New York intimates that the bulk of that almost $2,000,000,000 of beauty buying is done by women who were born to bloom unsung and unnoticed by the world—a vast section of the feminine population whose moods and skins need to be softened by the gentle manipulation of expert fingers weighted with fragrant creams, and whose talent for chatty conversation finds an outlet and an audience in thick and tepid air that smells of soap and singed and drying hair.

France, the great civilizer of Europe, never had such hectic cosmetic days. In the light of these stupendous figures how insignificant seems the fact that Madame de Pompadour's household at Choisy managed to spend 500,000 livres (about $100,000) for perfume alone.

And as decadent Rome, effeminate and effulgent from over cosmeticizing, and over-perfuming, fell before the malodorous masculinity of barbarian hordes—so too did the empire of du Barry and Pompadour, Versailles and the lady-like Louises—crumble before the unlovely and perfumeless though not odorless rabble that maneuvered the French revolution.

Not indeed that we would draw morals and inferences from these recitals as we consider our own nation's cosmetic indulgence, for between our days and the days of Rome are no comparable conditions. Only the rich in Rome—and the favored few of the Court of France—could afford these inordinate luxuries. The perfumed eras of the Empire of the Fleur de Lys meant the plunging of the peasantry in interminable debt from constant and extortionate taxation. The balmy sweet-scented baths of Rome robbed the governing race of the vitality and virility wherewith that valiant city had extended its ramparts to every corner of earth.

A COSMETIC DEMOCRACY

But not so with America—for our cosmetic frailties are diluted by spreading over so much territory, and so they incur no envy and accomplish, if sensibly handled, but little basic damage. With us even our vanities are those of a democracy, and rich and poor alike share commensurably in the pastimes and pleasures of this luxurious age.

And so we end the history—but not the mystery of the cosmetic kingdom. During the brief time left us we propose to glance at the array of cosmetic commodities in common use today, and comment carefully and perhaps abruptly on certain of their characteristics.

ROUGE

Let us start with the *paints*. *Rouge*—formerly made from ferric oxide, used by jewellers as a polishing paste—and present in putz pomade—is now made from carmine, carmoisine and various coal tar colors, mixed with talcum, starch or fullers earth and always properly perfumed. It is worthy of note in passing by that certain persons exhibit great intolerance to rouge containing carmine or alloxan, and should be diverted to using some of the harmless coal tar color rouges. The compact rouges contain a little gum arabic to afford the necessary adherence. Liquid rouges generally are made with glycerin and alcohol as the base.

EYE PAINTS

Eyebrow pencils and eyelash cosmetics are still made as they were in Egypt five thousand years ago—namely from soot, lampblack, burnt sienna and soap or wax and paraffin. One that came to our notice recently was a lacquer, to be applied with brush, and it was not at all unlike the compound used to finish automobiles—except that it cost as much per quarter pint as the two-tone lacquer costs per gallon.

LIP STICKS AND SALVES

These are usually a paraffin base, with wax or cacao butter reinforcement. They are generally colored with carmine, though the newest are tinted with colors from coal tar—mercurochrome the recent colorful antiseptic being extremely popular because of its adhesiveness and high tinctorial value. It might be well to note too that mercurochrome contributes a sanitary quality to the very unhygienic though romantic habit of osculation.

The ideal lip rouge will rub on smoothly and evenly and will neither come off with the soup nor be erased by osculation, hence the kissproof and soupproof lipsticks. The amenities of our modern civilization demand that rouged lips know no curfew bell, and an "evening rouge" is therefore available. This is usually prepared with a fluorescent dye such as eosin—a dye which by a strange coincidence finds much use in the hospital laboratory for staining pathological tissue.

Lip salves to prevent undue cracking and fissuring of lips generally have glycerinated gelatin for a base, with a mild antiseptic and soothing agent such as boric acid and menthol present. Greaseless lipsticks are readily made by tinting strong borate of glycerin with scarlet eosine. These have the advantage of being colorful, antiseptic, medicinal and serviceable day and night.

MANICURE PREPARATIONS

These comprise such softening creams as are used for the preliminary treatments, cuticle removers, bleaches, polishes and varnishes. The preliminaries are best done with water, flavored or from the Schuylkill, in which is dissolved a little borax and washing soda. The cuticle removers are mild solutions of caustic alkali (generally 2 per cent.) in glycerin and water.

The bleaches are usually made of tartaric or oxalic acid, or strong peroxide, all of which if over-indulged in may have a tendency to embrittle the keratin of the nail. Nail polishes are made from tin oxide or with various abrasive earths, perfumes and colors. The liquid polishes contain these materials suspended in glycerin, gum and water. Nail enamels are generally made of soluble gun cotton, and the proper solvents and plasticizers, often colored in exotic shades of red.

FACE CREAMS

These greasy or greaseless so-called skin foods are so diversified in their character that it will not be possible to discuss all the types in common use.

Their use in preserving the mellowness of the skin dates back to earliest antiquity, although the type of skin cream, exemplified by our mineral oil cold cream was never known to the ancients. Rather it was the vegetable or animal oil unguents or creams, rendered pleasing in odor by the addition of balsams and resins, which found so large a field of usefulness with the ancients.

And here we venture the opinion that the mineral oil cold cream, which constitutes the greatest group of greasy face creams now sold and dispensed, is not particularly beneficial to skin surface.

Far better are the cold creams made from the saponifiable vegetable or animal oils.

While the art of the ancients was in knowing how and not why—they often excelled us in the business of displaying good horse sense. It is well known in the laboratory that dangerous and malignant skin growths and tumors can be produced in the animal by constant exposure to crude mineral oil. This fact alone should be sufficient to warrant the claim that almond oil cold cream is far superior to any mineral oil cream, no matter how deftly aromaticized.

It is interesting to note here that cold cream as such owes its invention to Galen the famous Greek physician, who practiced in Rome during the second century.

The vanishing cream—whose name suggests its use as a reducing cream, though it has no such properties, is a soap base—generally made from stearic acid and washing soda. As a worthwhile cosmetic its reputation is doubtful and it too, won its favor through its flavor and good advertising.

Cucumber creams, almond creams, massage creams made of sour milk, lanolin creams, cacao butter creams, etc., all have their reputed purpose, but it is doubtful that any of them possess any advantage not possessed by a good vegetable oil cold cream.

Do face creams grow hair is a question often asked. If they radically did so, they would long ago have been used for hair tonics. Yet it is consistently urged that too frequent an application of the greasy creams, particularly the animal type, do promote the unwanted growth of hair.

FRECKLE CREAMS

Freckle creams usually contain a chemical such as white precipitate, a mercury compound, and are not always safe to use. Much more to the point with respect to curing freckles is the following instruction given in one of the comic magazines.

"Remove the freckles carefully with a pocket knife, soak them overnight in salt water; then hang up for two months in the smoke house with the rest of the hams. Freckles thus treated never fail to be thoroughly cured."

HAIR DRESSINGS

Shampoos we dismiss without much discussion, pointing out in passing that a good soap will do as well as any elaborately perfumed shampoo available, providing enough patience and elbow grease be administered in its application. Advertising agencies, of course, are not apt to agree with this statement.

Hair tonics have always been a matter of joke column discussion. Care of the hair is a procedure which can be scientifically and successfully conducted with very simple measures, and this is no time to discuss such measures—but it can be unqualifiedly announced that the spasmodic application of so-called hair invigorators and tonics may be expected to grow hair on a bald spot with as much certainty as sprinkling a bit of it on a Brussels rug may be expected there to develop a Chenile nap.

Hair tonics are available in very convenient sprinkling or massaging containers, and they contain almost every drug on the Pharmacopœia. Bugs, roots, poisons such as carbolic acid and bichloride

of mercury, leaves, heavy chemicals, dyes and all sorts of queer substances in alcoholic solution, are used in their manufacture.

Since dandruff, a parasitic disease, is usually associated with falling or decaying hair, hair tonics are frequently expected to do a double duty, namely cure the dandruff and grow hair as well. From the poisonous composition they frequently have they might be expected to be valuable not only in the treatment of the stationary dandruff, but also to cure that variety of dandruff known colloquially as jumping dandruff, or more scientifically as pediculosis.

Hair bleaches are most commonly of peroxide composition, and when generously used not only bleach the hair but rob it of its vitality as well. Hair never has been bleached white except through the agency of disease, old age, or trauma. Always when chemically bleached by oxidation or by reduction, the residual color is a yellow dog yellow—something of a cross bewteen the color of a November pumpkin and a burlap bag.

Hair dyes again, are a complicated group of preparations. Most of them are of dangerous composition, particularly the group containing coal tar compounds such as the paraphenylenediamin group. Their indiscriminate use can produce not only local irritations but constitutional diseases as well, and death has been known to ensue from their over-use or through idiosyncrasy.

One kind of hair dye, the silver type, actually silver plates the hair fiber, only that the silver is in such a form that instead of being lustrous and metallic it occurs as a microscopic black coating. Lead compounds too, are used for dyeing as well as for alleged tonic purposes.

The safest of the hair dyes are the vegetable colors mordanted on with such compounds as alum, etc. Henna, walnut, etc., are such compounds.

I have purposely omitted mentioning the marcelle or kindred hair treatments. These are physical heat processes which are unnatural to the hair and consequently if too frequently or too severely administered are bound to do damage.

DEPILATORIES The amenities of convention require the removal of hair from body surfaces, and it is a much easier chemical proposition to remove superfluous hair than to coax its growth. Certain chemicals such as sulphides, arsenates, etc., do this job about as well on the living human as they do on the carcasses of animals whose skin is desired for the tanning industries.

Generally all the depilatories are of the same base, only the perfume being different. The cheaper types, not so well perfumed, leave behind an odor suggesting a recently butchered fowl, whereas for three dollars more one can be secured whose trail is much more cleverly protected by captivating perfume. A Gillette razor of course, makes a splendid temporary depilatory. Nor must we forget the epilating waxes which work on the principle of a porous plaster, pulling out the hair by the roots. Then, too, there is the electric needle, a somewhat painful and tedious, though very thorough depilatory.

MUD PACKS

These face masks have a real value when properly applied, although their results are purely temporary. Glycerin and clay, such as fuller's earth, and the perfume, of course, constitute most of them. Their value lies in the fact that while drying on the face, they promote active surface circulation of blood and when removed they bring with them much of the dirt enclosed in the superficial skin pores.

ANTI-PERSPIRATION PREPARATIONS

These products usually contain a small amount of chemicals which locally stop the secretion of the sweat glands and neutralize or mask the offensive rancid odors so frequently associated with such secretions.

Such chemicals are alum, salicylic acid and compounds thereof. The indiscriminate use of these preparations is to be avoided.

REDUCING CREAMS AND PREPARATIONS

Possibly more sins have been committed by quacks and crooks in this field of cosmetics than in any other. The surgical end of it we shall leave to the plastic and cosmetic operator. The improvements in that stiletto profession have been so striking that terrace fronts may now be surgically removed without much risk to the tenant. Depending upon her ability to pay the necessary fees a woman disporting three or four chins may have one, two or three of them removed with little risk, and so return herself to monochinic complacency.

But this is not the place to discuss cosmetic surgery.

Rather it was our purpose to laugh publicly at the several tricks of the quack manufacturer—maker of bootleg cosmetics, who knowing the craze for sylph-like figures, has with his tricks misled many a stout sister to shed more coin of the realm than avoirdupois.

According to a recent report of Dr. Frederick Kebler, chief of the Division of Drugs, United States Department of Agriculture, these cosmetic sharks are reaping profits aggregating millions as a result of this craze for angularity in place of curves.

Co-operating with the Federal Postoffice in its effort to prevent use of the mails to defraud, Dr. Kebler has recently directed the investigation and analysis of more than forty so-called obesity cures, not one of which, he states, could be recommended as being both effective and non-injurious.

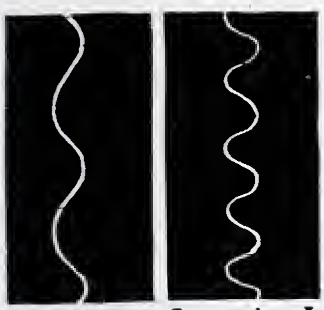
The remedies tested range from bath salts, chewing gum, pills and patent teas, to reducing creams and soaps. All of those examined, in the class involving internal use, have been found to contain a few cents worth of cheap phenolphthalein laxatives and simple household products such as epsom or rochelle salts, which could not conceivably aid a person intent upon losing weight. Many of the pills contain thyroid extract, which should never be administered except by a physician. Some of them contained iodine bearing drugs such as seaweed.

One sample of bath salts turned out to be common photographic "hypo," used probably because it has *reducing* effects in photography. On the same basis I recommend hydro-quinine as a splendid developer. Weak kneed, hollow-chested creatures take note. The creams usually have been found to be a soap containing some fancy perfume.

Heavy fines have been levied against manufacturers, convicted of fraud, and dozens of the remedies have been put off the market, but new ones keep cropping up to take their place. Dr. Kebler says profits on such products range from one to four hundred per cent., and it is not unusual for the annual net income of the promoter to reach six figures, sometimes hitting the half-million mark.

WATER AND OBESITY

Since the body contains much more than one-half water, and since water is the most volatile product in the *sober* body, it might be safely generalized that the usual path of body reduction is through water loss, a real desiccation or dehydration. That indeed, is how hot baths and sweat-producing devices function as body weight reducers. That too is the reason why all of these fraud preparations insist on very hot baths with every application of their product.



Rough Diagram Suggesting: Left—the long-wave Infra-Red rays; right—short-wave Ultra-Violet.

'RAY-'RAY
Get thin-growlight
with
light!

Fat Fades Away!

Watchful
Weighting!

Will you give me 10 days
TO PROVE I CAN MAKE YOU
SLENDER?

Feed Fat Away

It seems queer, but the modern method is to feed away excess fat. The food is a gland substance, taken from cattle and sheep. The amount decided by scientific tests is two grains a day.

The reason is this: Medical research has found that the great cause of excess fat lies in a weakened gland. It is really a disease. No exercise or diet can correct it.

Ad nauseam

compiled without permission
from current magazines.

DRIED APPLES AND PRUNES

On the same principle are apples and apricots dried and I have seen silly women who have carried reducing principles to extremes look just about as attractive in appearance as a dried apple or an arid apricot.

Typical of the bare-faced advertising that seeks to capitalize the craze of the rotund for contracting their outlines, is the following piece of ridiculous rot. (And this is from the columns of a *respectable* Philadelphia newspaper.) And, of course, the gist of the copy is in this reference to the unerring accuracy of the marvellous shrinking device.

"Lose weight where you most want to."

What a high sense of anatomic geography this simple medicine has!

NOW YOU CAN REDUCE 2 TO 4 LBS. IN A NIGHT

Eat what you please
Wear what you please
Do what you please
Take no risky medicine

Thousands of smart women have found this easy way to take off 2 to 4 pounds once or twice a week. These women take refreshing Bunko baths in the privacy of their own homes. Bunko is the concentrate of the same natural mineral salts that make effective the waters of twenty-two hot springs of America, England and Continental Europe. For years the spas and hot springs bathing resorts have been the retreat of fair women and well groomed men.

Excess weight has been removed, skins have been made more lovely, bodies more shapely and minds brighter.

LOSE WEIGHT WHERE YOU MOST WANT TO

Bunko reduces weight generally, but you can also concentrate its effect on abdomen, hips, legs, ankles, chin or any part of the body you may wish.

Results are Immediate

Weigh yourself before and after your Bunko bath. You will find you have lost from 2 to 4 pounds. And a few nights later when you again add Bunko to your bath, you will once more reduce your weight. Soon you will be the correct weight for your height. No need to deny yourself food you really want. No need for violent exercise. No need for drugs or medicines. Merely a refreshing Bunko bath in the privacy of your own home.

The thyroid gland is sometimes deficient in its heat producing qualities and so the body hangs on to its accumulated fat and protein. The properly controlled administration of dried thyroid may assist the body to so change the structure of the protein so that its jello-like quality of water retention be lost or minimized. But thyroid is dangerous medicine and should never be permitted in patent medicines—patent and potent too.

If it is in the "nature of the beast" to be fat—a sensible regulation of the diet, the cause and effect of over-avoirdupois—is the only rational prophylactic.

FACE POWDERS AND ENAMELS

It is obvious that air, light and changes of temperature are intended by Nature to reach the skin. Modern convention ordains that very little of the skin's surface is left exposed for Nature's agencies. Clothes, more or less, cover the entire body and today's fashions seemingly demand that powder or paint or paste shall cover the rest.

I have elsewhere rendered an opinion that this denial of light and air is highly unhealthy to the body. The surface of the body is meant to absorb light and to extract some of its qualities, imparting them to the surface circulation and thence through the blood into the intimate corners of the body.

Modern devices hinder this—the smoke of our cities, the light dispelling qualities of ordinary glass—our overwhelming clothes, and cosmetics. And with the chemicalization of our foods—and a consequent loss of locked up sunlight in vitamins, this modern denial of light and its values may be a prominent factor in the spread of that horrible disease of our present civilization—namely, cancer.

But since these important considerations in public performance are secondary to decoration, let it be stated here that if cosmetics of the covering kind are to be used at all, they should be used only as the occasion demands it, and well washed off when the occasion ends. It is important too that only such powders are used as are comparatively harmless in their ingredients.

Face powders, once loaded with bismuth and lead salts, are now fairly uniformly free of poisonous products. That such is still the case in foreign countries is attested to by the following clipping.

LEAD POISONING OF JAPANESE INFANTS BY FACE POWDER USED BY MOTHERS

A disease peculiar to Japanese children at the age of dentition is attributed by the author to lead poisoning due to the white face powder which is habitually used by Japanese mothers. It is stated that this disease is one of the chief causes of infant mortality in Japan, and has been prevalent for the last 200 years. The usual age of onset is eight months, and the disease is more prevalent in hot weather, due to increased use of the face powder by the mother. Fatal results are frequent, and lead is found in the body post-mortem. The source is always traceable to the face powder used by the mother.

Talcum, or powdered soap stone, the several starches insoluble magnesium and zinc soaps and salts, chalk, etc., are the bases now generally used. Perfect adherence to the skin, fineness of texture and admixture, color and the inevitable perfume, are the necessary qualifications of a good face powder.

Rice powder (*Poudre de riz*) is a face powder which sometimes contains rice starch, but more generally the less expensive Nebraskan corn starch. In an emergency the housewife might prepare a dessert from this cosmetic, providing the flavor suits.

Compact powders are essentially the same as above, compressed by machine into the customary shapes.

Note that all other qualities being equal, cosmetics are expensive or cheap, according to the attractiveness or crudeness of the label, and container, or the elegance or crassness of the perfume used.

The enamels or liquid face powders are chiefly glycerin, gum and water suspensions of the very finest kind of face powders—in other words a sort of a highly refined white wash or dry color alabastine.

The colors in face powders and rouges and enamels are as variable as the color of sunsets. This is only a partial list: Cream or Rachel, Brunette, Naturelle, Pink, Rose, Mauresque (sunburn shade), Ochre, Orange (for anemic ladies with auburn hair), Blue for shading the eyes Mauve and many other shades. There is quite an art in producing just the right tones and shades and an equally insistent art in the business of selecting the right one to suit the face, the weather, the occasion and perhaps the pocketbook.

One of the extremely exotic, esthetic, esoteric—and perhaps asininic French beauty "doctors," has prepared a chart of face powder modes and moods—the mode fitting the mood and the mood benefiting by the mode.

That the fad of face kalsomining is being objected to by economically inclined beaux is testified to by this bit of "poetry" borrowed from "Life":

"In the gloaming, Oh my darling,
When the lights are dim and low,
That your face is powder-painted
How am I sweet heart to know.
Twice this month I've had to bundle
Every coat that I possess,
To the cleaners—won't you darling
Love me more and powder less."

SOAPS

"The skin you love to touch"—according to one famous soap advertisement, got along for many a century without soap and sometimes I wonder whether a little less soap and a bit more weight and water might not produce a far healthier cleanliness.

The story of soap has already been written by Professor Cook in a former popular lecture, and I dismiss the subject with the statement that soap is soap whether perfumed or colored or medicated, or whether just a plain garden variety of soap. In other words

"A soap by any other name,
Washes quite as clean."

The presence of free alkali in soap is to be interdicted, but ordinary soap releases free alkali as soon as it hits water anyway.

And so, with a feeling that we have dealt only very superficially with our subject, we must bring our story to its close. Too long we remained with its historical phase—and not long enough perhaps with its equally interesting hysterical and compositional phase. But we may later return to that part of the story and treat it more liberally and completely.

"Sanity" and "sanitation" are derived from the same root word. "Mens sana in corpore sano" is a well established proverb. And the sanitary aspects of cosmetics too are largely governed by sane viewpoints. I terminate my already lengthy remarks by repeating that, with this human—very human tendency to decorate and adorn—is no sin where moderation and sound sense prevail.

And the words of a very commonplace verse seem to fit quite adequately into this closing paragraph.

"Reformers all say, each in his own way,
That this thing or that will hurt you.
But remember my lad
With good and with bad,
Too much of a thing is ever the sin
And exactly enough is the virtue."

SNAKES AND SNAKE PROTECTION

By Louis Gershenfeld, Ph. M., B. Sc., P. D.

Professor of Bacteriology and Hygiene, Philadelphia College of Pharmacy and Science

JUST AS THE term bacteria frequently inspires terror in many individuals so does the term snakes bring awe and fear to many thinking and reasoning humans; and just as most members of the former class are harmless and some useful, so among the snakes are most of them harmless, and in fact, many are friends of agriculture. To-day they even find an extensive use in commerce. Why is it that humans and almost all animals become panic-struck at the sight of a snake and seem at once deprived of all their powers, including that of motion? Why should there exist such a fear and dread, and even an obsession against snakes? Why should the popular attitude (of adults) towards snakes be hostile? Why does the mentioning of snakes (even in name only) create such an antipathy and disgust? Occasionally a plausible excuse is available but in many instances, the whys and wherefores are unexplained. For the average individual a snake is a snake and for the more intelligent they fall into two divisions, those which are poisonous, and snakes which are harmless. In a way such a classification may be satisfactory, but a grouping as this tends to leave the impression that the poisonous snakes form one distinct group and the non-poisonous snakes form another group, both being unrelated. This is far from the actual facts, and as we will see, both arise from a common stock.

Louis Gershenfeld, Ph. M., B. Sc., P. D.

Snakes belong to the Class of Reptiles. Now the Class Reptilia consists of many Orders. Let us first get a bird's eye view of the subject involved and the relationship of snakes to other members in this class. The classification which follows is a very brief outline:

CLASS REPTILIA

I. Rhynchocephalia—This is represented by one single species, the curious Sphenodon, inhabiting New Zealand and the last remnant of an Order once widespread and abun-

dant and now extinct. Lizard-like in form, it differs in skeleton and anatomy from all other living reptiles.

II. Chelonia—Turtles and Tortoises found here are enclosed in a bony shell. They are generally distributed throughout temperate and tropical areas, the former being semi-aquatic and marine and the latter terrestrial.

III. Crocodilia—The Crocodilians—Crocodiles, alligators and the South American caymans. These differ from other reptiles mainly in the fact that there is a muscular diaphragm between the thoracic and abdominal cavities and the ventricle of the heart is completely divided. They are mainly semi-aquatic and generally found in tropical and semi-tropical regions.

IV. Lacertilia—The Lizards. In the latter the ventricle is undivided with the presence of the typical reptilian heart; there is no shell about the body; the branches or rami of the lower jaw are united by suture and they possess paired copulatory organs. There are nearly 2600 species of lizards only two of which are poisonous, the latter being the Gila Monster found in the desert regions of Southern Arizona and New Mexico (the valleys of the Gila River and its tributaries) and the Mexican Beaded Lizard ("Escorpion") found in Central and Western Mexico to Northern Central America. These two poisonous species of lizards have fangs on the lower jawbones.

Lizards are found but infrequently in temperate climates and are usually general throughout tropical and semi-tropical areas. They may be terrestrial (ground or on land); subterraneous (burrowing or underground); arboreal (on trees) or semi-aquatic. There is an array of varied forms differing widely in size, structure, habits, etc. The typical lizard possesses a scaly coat, characteristic for each species, and usually four developed limbs. A tapering tail used mainly for purposes of defense, a peculiar and characteristic arrangement of teeth and as a rule functional eyelids are present. In some species of lizards where the limbs and scales have disappeared and these reptiles, gliding along like snakes, resemble the latter, the presence of the functional eyelids is an important means of distinguishing them from the snakes. There are no snakes which would be mistaken for lizards but there are lizards which many observers may mistake for snakes.

V. Ophidia—The Snakes. The branches or rami of the lower jaw in the latter are united by a ligament and not by suture. Approximately two thousand species of snakes have been classified. With the exception of the Arctic and Antarctic regions, snakes are found almost

everywhere. They are far more abundant in the temperate zone than the lizards. Some of them, especially these days, are of value to man. Most of them are valueless. About one-quarter of all species are harmful, in fact many of these are dangerous and even fatal, and it is these snakes which it is well to recognize when encountered. Due to their habits, and especially during feeding when they seek seclusion so as to assimilate food, snakes are not commonly observed in as large numbers as actually present. Variations in size and structure are more marked among snakes than among the other reptiles. We have on the one hand species of burrowing snakes, but 4 to 6 inches in length, with the thickness of a goose quill, and on the other hand, there are species of the Python, from 20 to 30 feet, or the Anaconda, monarch of the Boas, credited with a length of 40 feet and higher with a proportionate girth.

Differences between True Snakes and legless lizards are not at times very marked. The chief points involve the bones of the head, in particular those of the lower jaw. Among lizards, the lower jaw is single—among snakes, the lower jaw is composed of two elongated, almost straight bones, connected in the front merely by an elastic ligament. There is also a much greater elasticity present, enabling a snake to engulf its prey entire. In the swallowing performance and the anatomy of those parts concerned therein, we find a marked difference between snakes and lizards. Another important characteristic as mentioned is the absence of eyelids. There is an assortment of species of snakes—some stout, others excessively slender, terrestrial, arboreal, subterraneous or aquatic in habits, their patterns embracing an amazing display of designs and hues. The classification of the Ophidians is a task attended with great difficulty. In classifying the snakes, the scales, rows of scales, structure of head shields, number of abdominal plates, and in particular, the dentition are carefully noted and employed as important aids.

BIBLICAL REFERENCES AND DERIVATION OF NAMES, REFERRING TO SNAKES

You will observe from the brief outline given that a snake is a reptile but not all reptiles are snakes. All Ophidians are snakes and in like manner the scientific names of the various divisions, which will be mentioned, are finding their way into our everyday language. These refer to specific groups of snakes. But there are several other names that have come down to us from the Bible and literature which are as we may regard them synonyms for snakes. The science

dealing with the study of reptiles is known as herpetology. The word "Reptiles" is derived from the latin, reptilia, creeping things. The term reptile is frequently employed as an adjective to describe a human whose qualities are contemptible, sneaky and malignant. The origin of the word "Snake" is uncertain. The term "Serpent," which is used even more frequently and is practically synonymous with "Snake," is derived from the word serpere, meaning to creep. It is this word which is employed in an allegorical sense when referring to a subtle and dangerously fascinating person.

There are several Hebrew words which indicate forms of serpents and which are variously translated. Some of these ("Tzepha," "Akshub," "Pethen" and "Shephiphon") and their translations will be considered later. Then we hear of "Epheh," which is usually translated as "Viper." "Nachash" refers generally to any kind of a serpent, while "Tannin," though translated as serpent in Exodus, 7:9, is more frequently rendered "dragon" or "sea-monster," as in Genesis, 1:21, and Job, 7:12. The word "Saraph" as found in Numbers, 21:6, and Deuteronomy, 8:15, is translated as "fiery serpents," but there is nothing to indicate what this refers to. The following Biblical references to the serpent are to be found:

Genesis, 3:1, 2, 4, 13, 14, 15: "The serpent more subtil than any beast of the field deceiveth Eve and is finally cursed by God." The story of the snake tempting Eve is handed down by all religions and all people accordingly seem to feel that this reptile possesses some peculiar virtues though it is more than likely of a purely superstitious origin.

Genesis, 49:17, "Dan shall be a serpent in (by) the way."

Numbers, 21:9, "A serpent of brass was made by Moses, as ordered by God."

II Kings, 18:4, "Hoshea, son of Elah king of Israel, broke in pieces the brasen serpent that Moses had made."

Isaiah, 14:29, Serpent's root, basilisk (cockatrice) and flying serpent are all to be found mentioned here.

Isaiah, 27:1, and 65:25, where in the glory of the restored nation, mention is made "and dust shall be the serpent's food."

Amos, 5:19, "and a serpent bit him."

Micah, 7:17, "They shall lick the dust like a serpent."

Psalms, 58:4, David, in reproving the wicked judges, says, "their poison (venom) is like the poison (venom) of a serpent."

Psalms, 140: 3, David, in praying to be delivered from Saul and Doeg, speaks of the evil man and the violent man, and says, "They have sharpened their tongues like a serpent; adders' poison (vipers' venom) is under their lips."

Proverbs, 23: 32, in speaking of wine, says, "at the last it biteth like a serpent and stingeth like an adder (basilisk)."

Proverbs, 30: 19, in Agur's confession of his faith, he mentions four things which are hard to be known, and one of these is "the way of a serpent upon a rock." It is probable that this refers to the gliding motion of a snake when progressing.

Job, 26: 13, Job, in reproving the uncharitable spirit of Bildad and acknowledging the power of God to be unsearchable, says, "His hand hath formed (created) the crooked serpent."

Ecclesiastes, 10: 8, "and whoso breaketh through a fence, a serpent shall bite him."

In the New Testament, the following references to "serpent" are made:

St. Matthew, 7: 10, the question is asked what man will give his son a stone if he asks for bread "or if he ask a fish, will he give him a serpent"? 10:16, in giving the apostles their charge, they are comforted against persecutions and it is here where we hear the oft-repeated phrase, "Be ye therefore wise as serpents." It is probable that the wisdom and subtlety ascribed to the serpent arises from the cunning with which it avoids dangers.

A similar quotation is found in St. Luke, 11: 11.

St. Mark, 16: 18, in sending forth the apostles to preach the gospel, they are instructed in the signs which shall follow them that believe and one is, "They shall take up serpents and if they drink any deadly thing, it shall not hurt them."

St. John, 3: 14, "and as Moses lifted up the serpent in the wilderness."

I Corinthians, 10: 9, "and were destroyed of serpents."

II Corinthians, 11: 3, reference is made to the fact that "the serpent beguiled Eve through his subtilty."

Revelation, 12: 9 and 20: 2, "That old serpent, called (which is) the Devil."

The Hebrew word "Tzepha" is translated by some as "basilisk" and by others as "cockatrice." It is variously regarded as a kind of serpent, lizard, or dragon, though in most cases it evidently refers to

some venomous snake. In olden days such a serpent was supposed to be able to "look people dead."

The Cockatrice is a fabulous serpent or serpent-like monster anciently believed to be hatched from a cock's egg. It is often simply another name for the basilisk. Other than those already given, Biblical references to this term, though basilisk is also given as the translation, are to be found in: Isaiah, 14: 29, and Jeremiah, 8: 17. The basilisks are scientifically to be found in the genus Basiliscus, family Iguanidæ, order Lacertilia (lizards).

The term viper is the translation of the Hebrew word "Epheh." Biblical references other than mentioned are to be found in Job, 20: 16: "He shall suck the poison of asps; the viper's tongue shall slay him." In the new testament in St. Matthew, 3: 7, John the Baptist reprehends the Pharisees and Sadducees and "he said unto them, 'O, generation of vipers' "; and in Acts, 28: 3, Paul suffers shipwreck but lands safe on the Island Malta, is kindly entertained by the "barbarous people" and when gathering sticks and laying them on the fire "there came a viper out of the heat, and fastened on his hand." This viper was probably the Mediterranean viper (Vipera aspis), which though not to be found at present in Malta, occurs in many of the Mediterranean islands.

Several distinct Hebrew words are translated as "adder." In all, the idea conveyed seems to be that of some form of venomous snake. It is employed as a colloquial name for several poisonous snakes mostly belonging to the family Viperidæ, such as the Copperhead, Moccasin, etc., and also for certain harmless snakes of the family Colubridæ, particularly the spreading adder (Heterodon platyrhinus), which when angry resembles the poisonous snakes. In England the name denotes the only venomous snake of Great Britain—the European viper (Pelias berus). The Hebrew word pethen, translated elsewhere as asp, is spoken of as the adder in Psalms, 58: 4 (where in speaking of the wicked, it is said "their poison (or venom) is like the poison (or venom) of a serpent; they are like the deaf adder (or asp) that stoppeth her ear."). This probably points to the Egyptian cobra (Naja haje)—for continuing in paragraph 5, we hear "which will not hearken (or hearkeneth not) to the voice of charmers." Another word "Shephiphon," translated as the adder, though given by others as the "horned snake," is to be found in Genesis, 49: 17, when Jacob, speaking of Dan, says, "Dan shall be a serpent by (or in) the way, an adder (or horned snake) in the path." This refers probably

to the well-known horned snake Cerastes hasselquistii common in Egypt. The word "Akshub," found in Psalms, 140: 3, when speaking of the evil man and violent man, says, "adder's poison (or viper's venom) is under their lips," is translated as adder, though others apply this term to various poisonous snakes (vipers). In the New Testament, Romans, 3: 13, the same word is translated by asp. The word "Tziphoni," found in Proverbs, 23: 32, when speaking of wine, says, "at last it biteth like a serpent, and stingeth like an adder" is rendered as "adder" and "basilisk" or "cockatrice" by others.

The Hebrew word "pethen," though translated by some as adder, is most frequently translated as asp. The asp is a venomous snake. The name as applied in the Bible refers probably to the hooded or African cobra (Naja haje), common in Egypt and often represented in hieroglyphics. The ancient Egyptians were led to believe that the Asps were the guardians of the spots they inhabited. The figure of this reptile was accordingly adopted by them as an emblem of the protecting genius of the world. References in the Bible may be found in Deuteronomy, 32: 33, "their wine is the poison of dragons (venom of serpents), and the cruel venom (poison) of asps"; Isaiah, 11: 8, "and the sucking child shall play on the hole of the asp, and the weaned child shall put his hand on the cockatrice (basilisk's) den"; Job, 20: 14, "yet his meat (food) in his bowels is turned, it is the gall of the asps within him"; Job, 20: 16, "he shall suck the poison of asps, the viper's tongue shall slay him," and in the New Testament, Romans, 3: 13, in speaking of the Jews' prerogative, the statement is made that "there is none that doeth good, no, not one," and later on "the poison of asps is under their lips."

LITERARY AND OTHER REFERENCES

It would be a long and tiresome task to trace the serpent as it figured in our early history and literature. It would be an ambitious task for an interesting piece of library research. The snake or serpent as we find it came into our literature as the snake of the Bible, a thoroughly despicable creature and that to a great extent, this type was not modified except in few instances where the scientific trend may have correctly influenced the literary mind. The snake appears in every literary form—poetry, prose and ballad, and in the drama. The sum total of the analyses of the snakes' various roles is a tale of hypnotic influences, subtleness, danger and hate. Instances (other than scientific) in which the snake is favorably treated are few in number and

to locate them would be like trying to find a quinine pill in a barrel of camphor balls.

The subtlety of the serpent is commended by Aristotle and several naturalists. John Milton, in his "Paradise Lost," mentions the serpent as being selected for the instrument to tempt Eve and speaks of "the serpent subtlest beast of all the field" and the "wily adder." History during the days of Moses relates several interesting references to the ancient magicians and what they did with their serpents. The Psylli or ancient serpent-tamers are mentioned in several writings. Savary gives an account of the modern serpent-tamers in his "Letters on Egypt." The most wonderful of Shakespeare's historical plays, the one in which he has followed history so minutely, is the tragedy of Antony and Cleopatra, in which Cleopatra as tradition has it, determines to follow Antony to a speedy death and perishes by the bite of an Asp secretly brought to her in a basket of figs. There are several fables and fairy stories in which individuals are portrayed as possessing traits of serpents. These stories are not based on any well-ascertained physiological fact. They are merely speculative fancies as is to be found in Melusina, the fairy, who for some offense was changed from her waist downward every Saturday to a serpent. Then there is Keats' "Lamia," a most beautiful poem in which an imaginary being is the subject of magical transformation into a serpent. In Coleridge's "Christabel," Geraldine is referred to as a malignant witch-woman with the evil eye but with no absolute Ophidian relationship. The idea conveyed is of course mythological and not in any sense physiological. Yet in this connection it is interesting to note that just last month in our own city a contest in a half million dollar will was started in which the relatives claim that the testatrix complained of being "pursued and haunted by a man with snake eyes." These relatives were ignored in the disposal of the estate in favor of this "man with snake eyes."

With the exception of the legend of Eve, the snake story of literature was written by Oliver Wendell Holmes, author of the "Autocrat of the Breakfast Table." This snake story first wearing the title of the "Professor's Story," was later changed and is now known as "Elsie Venner." Elsie Venner, a girl poisoned by the venom of a rattlesnake before she was born (prenatal influence), is utilized as the starting point of an imaginative and very interesting story, in which she is shown as being cold, possessing a hypnotic influence and a mysteriously envenomed nature and is unable to love even though

she wants to. In the "Letters of Oliver Wendell Holmes" we also find some very interesting correspondence between Dr. S. Weir Mitchell and the physician author in which Dr. Mitchell mentions some of his researches on Serpents, Venom of Rattlesnakes, etc., which were later published. It is also interesting to note that Dr. Holmes had a rattlesnake in his laboratory for a long period of time. Here he studied minutely at first hand the habits and other traits of this species of snake before writing his "Elsie Venner." When Dr. Mitchell sent to Dr. Holmes the skin of a large rattlesnake it was he who replied, "His bark is much more welcome than his bite would be."

Of course, you all know Kaa, the python, made famous by Kipling in his "Jungle Book," and his white cobra, which he also mentions here. Pope, in one of his poems, makes some interesting remarks concerning the rattler. And then without mentioning other literary references, it might be of interest to observe some instances where snakes are employed alone or with other symbols. Caduceus, the staff considered as a symbol and attribute of the Greek god Hermes and the Roman god Mercury is generally represented as having two serpents twisted around it in opposite directions, their heads confronting one another. Several different fables were invented to account for the presence of the serpents. The one most frequently quoted is that Apollo gave his staff to Mercury, who with wand in hand as he entered, saw two serpents fighting together. He threw the staff between them and they immediately wound themselves around it in friendly union. Among the moderns the caduceus serves principally as an emblem of commerce over which Mercury was the presiding divinity.

Æsculapius (Asclepios), the god of medicine among ancient Greeks and Romans, is commonly represented standing dressed in a long cloak with bare breast. His usual attribute is a club-like staff with a serpent, the symbol of renovation curled around it. This points to an ancient godly spirit. Whether this symbolic turning of a serpent around the staff of Æsculapius indicates a belief in its endowment with some extraordinary virtues in connection with the healing art is problematical. The cult of this Son of Apollo, who was deified as the god of medicine, spread rapidly after its introduction by Sophocles in Athens. At the foundation of each new temple a serpent, symbol of the healing god, was provided. Most of these temples kept non-poisonous, tamed and trained snakes which were

often employed for all manner of jugglery. The snake or worm largely represented the Egyptian's idea of disease.

From the earliest origin of Hinduism, its followers have worshipped the Cobra, representing it in pictures and in sculptures with many heads as a protecting divinity overshadowing kings and deities. Even to-day, the presence of a living Cobra in the homes of many natives in Asia is considered by them as an omen of prosperity.

There is an interesting book entitled "Serpent Worship—Ophiolatreia," which gives an account of the rites and mysteries connected with the origin, rise and development of Serpent Worship in various parts of the world, and it is enriched with interesting traditions and a full description of the celebrated Serpent Mounds and Temples.

SCIENTIFIC WRITINGS

It is impossible to give a detailed list of all who have written valuable scientific and general treatises on herpetology (the study of reptiles) or on observations of the characteristics of snakes. Almost all works on zoology describe and give certain valuable information concerning snakes. There are many interesting treatises upon the subject by writers who have been called to the far beyond. Of these, the works by Dr. S. Weir Mitchell and Dr. Noguchi are of interest. In considering recent writings, the following authors in particular must be mentioned when presenting any article on snakes.

Dr. E. G. Boulenger, the Great Belgian herpetologist, long at the British Museum, has written many of the most valuable works on Herpetology. Dr. Raymond Lee Ditmars, Curator of Reptiles and Mammals for the New York Zoological Society, has written several comprehensive books and articles, popular and scientific, which are invaluable in any study on Ophidians. Dr. Thomas Barbour, Director Museum of Comparative Zoology at Harvard University and of the Experimental Station and Serpentarium at Tela, Honduras, has contributed some interesting volumes and accounts of reptiles and amphibians. Dr. Leonhard Stejneger, of the United States National Museum, has presented several interesting works. Dr. Albert Calmette, of the Pasteur Institute, and Dr. Vital Brazil, known by some as the "snake farmer" of Brazil, are the pioneers in the production of anti-snake-bite serum, the former producing a preparation for use in India and Oriental countries and Dr. Brazil, producing a preparation for use in Brazil. And for the last name I leave the one who is without a doubt one of the most interesting authorities in the Western

Hemisphere to-day, Dr. Afranio do Amaral. As the first Director and at present the consulting Director of the Antivenin Institute of America at Glenolden, Director of the Seropathic Institute of Butantan, Sao Paulo, Brazil, and Lecturer at Harvard University School of Public Health, he has and is contributing through the Bulletins of the Antivenin Institute of America, and lay and scientific journals valuable data concerning venom, treatment of snake bite, antivenin, as well as general information concerning snakes.

There are of course many other works which are not mentioned here due to the fact that they comprise a small restricted or localized fauna and also for the reason that this is not intended to be an exhaustive list but merely one in which is to be found the authors of the most valuable treatises upon the subject of snakes.

SNAKE TALES AND SNAKE MYTHS

Who doesn't know a snake story?

Harking back to the earliest periods of time till even the present-day snakes were and are endowed by man with a multitude of virtues, all sorts of mythical attributes and peculiar beliefs which are shared by young and old alike. The element of truth in most of these stories is practically nil. For the most part such stories are fables, delusions or superstitions. You may read these and enjoy them as mythical stories but not as truthful narratives as some people would want us to believe. The following are the most persistent and widespread snake myths or superstitions worthy of mention:

1. A snake when killed does not wait until sundown to die nor does the tail of a dead snake wiggle until the sun goes down.

2. Snakes do not swallow their young or the latter do not run up its mother's throat at the approach of danger and the mother does not spit them up again when danger has passed. If this ever occurred the strong digestive fluid in the stomach of the mother snake would kill the eggs. What probably happened was that the mother hid the young under its own body for the time being so that they are not observed. Snakes eating young and smaller snakes (cannibalistic) and the finding of living broods ready to be expelled have led to this tale.

3. The tips of snakes' tongues are not poisonous fangs.

4. The spreading or hissing viper, blow snake or puffing adder, or hog-nosed snake due to its actions of hissing, striking, other alarming manœuvres, and its habit of feigning death have given rise to

various superstitions and stories. It does not blow a poisonous powder or spray from its mouth. It is entirely harmless. All of its acts are a blüff and it merely seeks to frighten its enemy. It is undoubtedly a pugnacious, vicious-looking and terror-acting snake, but looks have never killed anyone.

5. The milk snake (Ophibolus doliatus) or other snakes do not steal milk from cows or from dairies. The story is as ridiculous as it is untrue.

6. The number of rattles possessed by a rattlesnake does not indicate the age of the snake (tradition has it that each joint to the rattle means one year added to its age) nor does it indicate the number of human beings killed (the Indian tradition has it that each rattle indicates the death of one human being). These stories are merely idle fancies.

7. Not all snakes that produce a rattle are rattlesnakes. Snakes like the bull-snake and others vibrate their tails violently when excited and their tails may, when in contact with leaves, twigs, boards, etc., produce a realistic rattle. These snakes, however, do not have rattles or segments of dry horny skin as do the rattlesnakes.

8. The coach-whip snake (Zamenis flagelliformis), swift-moving, slender, almost as thin as a whip, is entirely harmless and does not snap its body like a whip as many of the superstitious folks in the South believe. It may on rare occasions follow a moving, unaccustomed object for a short distance, but it will never overtake you, coil itself around your body and thrash you with its tail, thus torturing you to death.

9. The red-bellied snake, also known as the "hoop snake" (Farancia abacura), is endowed with a tail which is armed with a minute spine as sharp as a needle. This tail cannot pierce or sting anything.

10. This "hoopsnake," previously mentioned, does not have horns on its tail and it is unable to place its tail in its mouth and roll along like a hoop. Such story is entirely mythical.

11. Poisonous snakes do not necessarily coil before they strike. Contrary to belief snakes with but very few exceptions do not attack humans wantonly. Most snakes are really lazy and timid and strike only when hurt or threatened with attack.

12. Snakes cannot hypnotise nor are they possessed of the mysterious powers of "charming." The fear developed, or the fact of becoming panic-struck at the sight of a snake with the result that one's

power of motion or the exercise of other powers are at a standstill, have led to this belief.

13. Snakes do not go "stone blind." They may during shedding show impaired vision, but not complete blindness.

14. Snakes cannot and do not travel on a smooth surface. They cannot and do not climb trees in spiral fashion. Poisonous snakes cannot and do not jump completely off the ground when striking.

15. Alcohol internally or externally is not a remedy for snake bites. In fact its use is harmful. You have heard all kinds of stories about people getting drunk after being bitten by a snake and that this served as the proper remedy. In those cases, the biting was done by a harmless snake and in the few instances where it might have been a poisonous snake, the fangs did not penetrate deeply into the skin or they did not deposit a sufficient amount of venom to exert a harmful effect, so that no treatment at all would have done the same amount of good and undoubtedly more when we consider the physiological action of the alcohol. You know the story they tell about the fellow who, unable to get any liquor, ran into the tavern and asked to have wrapped quickly two quarts of whiskey to use for a snake bite. When the remark was made that two quarts was SOME DOSE, his reply was that the biting was done by SOME SNAKE.

ORIGIN OF SNAKES

Reptiles sprang from the Amphibia, which in turn came from the fishes. The Amphibians known today, including the frogs, the newts and salamanders, the legless cœcilians (which at first sight resemble earthworms), are perhaps more specialized than the ancient order of this class which undoubtedly display the relationship just mentioned. Amphibians differ from the Reptiles not only in possessing a soft, slimy, scaleless skin, but they normally pass through a larval stage during their cycle of life.

Among the reptiles themselves, the average observer seems to regard snakes as primitive and not as highly developed as the lizards. The actual facts are that the latter are the more generalized group from which the snakes have sprung.

CLASSIFICATION OF SNAKES

I will attempt to present a consideration of snakes as a whole and in a general way. Elaborate descriptions of individual species is impossible and all that can be accomplished in the time allotted is to limit myself to a con-

sideration of classes and groups. Your interest will also be directed mainly to the North American Snakes though a general idea of the other Snakes or Ophidians will be given so that you may have some comparison between the different members of this Order.

NECESSITY FOR SCIENTIFIC OR TECHNICAL NAMES

Names common to particular species of snakes may vary, depending upon the location, so that the same species of snake may have several names by which it is known. In rare instances, a name common in one territory may apply to an entirely different species of snake than the species to which this same common name is applied in another area. It is for these reasons that scientific names are required for absolute identification of a species as such name is employed the world over by those interested and under no conditions do we have the same species labeled with different scientific names, due to differences in locations. In most instances scientific names have also an interesting or descriptive meaning. Take the Crotalus horridus, commonly found in the mountainous areas of Pennsylvania and also occurring from Central Vermont to Northern Florida and westward to Iowa, Kansas and Eastern Texas. The name Crotalus means "rattle," while horridus means "terrible." Due to its cross bands of color, it is known as the "banded rattlesnake." In other territories it is known as the "timber rattlesnake" due to its fondness for mountainous ledges, scattering to the timber during the warm months. In the cane-brakes of South Carolina and in fact all along the South, it is known as the "cane-brake rattlesnake." Unfortunately in some areas the name "diamond rattlesnake" is applied to this species. This latter synonym is apt to be confusing, for other species of rattlesnakes carry this title.

Perhaps I may suggest another good use for these scientific names. Farmers in various localities are troubled by trespassers who kill harmless snakes which, as the effective natural enemies of rats and rodents, save their crops. To those farmers who are aware of the great value of the numerous harmless snakes and don't want them killed, I would suggest the following notice at conspicuous points about their premises:

Trespassers, take warning! All persons trespassing do so at their own risks, for although common snakes may be found here, the Pituophis sayi abounds everywhere about here and never gives warning of its presence.

The Pituophis sayi is the Bull Snake (or any other scientific name of the species valuable to the farmer and prevalent on that farm may be inserted). The average individual would probably not molest such place due to the fear which would be imparted by what he would believe is a deadly enemy bearing the scientific name on the sign. The valuable snakes would do their work and the farmer would be able to gather the maximum yield of his crop in peace.

CLASSIFICATION ORDER OPHIDIA

Family—Typhlopidæ—These are small, degenerate, harmless, burrowing snakes, the upper jaw only being toothed, and they look like the degraded lizards or even worms. The many species of the few genera are to be found in Central and South America, West Indies, Mexico, Southern Europe, Southern Asia, Africa, Australia and Malay Archipelago.

Family—Glauconiidæ (Blind Snakes)—In here are found diminutive burrowing, harmless snakes, the lower jaw only is toothed, and these species are observed in the warmer parts of the Old and New World. They feed upon worms and insect larvæ.

Family—Boidæ—Subfamily—Pythoninæ (Pythons) (containing a bone, the supra-orbital, above the eye, and absent in the Boas and other snakes) and Subfamily—Boinæ (Boas). There are many diminutive and moderate size species. Some are arboreal and others burrowing. The Pythons and Boas, better known for the presence of species of large dimensions are among the most sensational of the reptiles. Members in this family, though true snakes, are characterized by the protrusion of a pair of internal hind legs in the form of a pair of stout spurs, which are vigorously movable and also capable of inflicting an ugly scratch. Vestiges of these hind limbs terminating at times in a claw-like spur may occasionally be visible externally. All species are devoid of venomous properties, but the monster Pythons are capable of producing formidable lacerations with their long, recurved teeth. They are capable of crushing to death and even swallowing humans, but they are rarely bold, or hungry or vicious enough to do this. They, however, live upon warm-blooded prey, either mammals or feather creatures, as pigs, chickens, etc., and they usually kill their prey by constriction due to the presence of strongly developed muscles. The Pythons are confined to tropical and semitropical areas of the Old World while the Boas are to be found in both hemispheres. Differences between Pythons and Boas are confined mainly to the bones of the head and the arrangements

of the head plates. The king of the big constrictors is the Regal or Reticulated Python, known by the natives of Malay as the Ular-Sawa and which may grow to a length of 30 feet, very stout in proportion to its length, weighing approximately 300 pounds and possessing a coloration the beauty of which is beyond description. Pythons usually lay their eggs, coil about them until they hatch in about two months' time. Most of the Boas bring forth their young alive. Of the Boas, the largest one to be seen in this hemisphere is the Anaconda or Water Boa of Central and tropical South America, which may be as long as 30 or more feet. Laymen seem to indiscriminately label all big snakes (whether Pythons or Boas) as Boa Constrictors. The specific Boa Constrictor or the Common Boa, a native of tropical South America, is in reality not an especially large snake, being rarely over 12 feet. It is a reptile of generally docile nature, takes readily to captivity and therefore sought by snake "charmers." In the United States, especially along the Pacific Coast region, a few small species of Boas are to be found. These are the Rosy Boa (Lichanura roseofusca) occurring but infrequently; the Three-lined Boa (Lichanura trivirgata); and the Rubber Boa (Charina bottæ), which is also popularly known as the Two-headed Snake, because the tail is almost as blunt as the head. In Cuba and Porto Rico, both of which islands are free of poisonous reptiles, a big and powerful species found is the Cuban Boa which when it strikes emits a hiss sounding like a sneeze.

Family—Ilysiidæ—In here are to be found a few burrowing species and other small, harmless, constricting snakes, closely allied to the Boas and which are mainly found in damp forests (usually at some elevation) in Asia and tropical South America. Many species are beautifully colored.

Family—Uropeltidæ—Here are listed a large number of small, harmless, burrowing snakes inhabiting India and Ceylon.

Family—Xenopeltidæ contains a harmless burrowing species found in Asia.

Family—Colubridæ—This the largest family of the Ophidia, found all over the world, is a very cosmopolitan family, for almost 90 per cent. of all living snakes are found listed here. It is the members of this family which are most frequently seen and which leave one with the general impressions formed concerning snakes. There is an assortment of forms, sizes, habits, and varied coloration. They may be arboreal, terrestrial, subterraneous, semi-aquatic, persistently

aquatic, and marine species are also known. Many are harmless; some are powerful constrictors, others bolt their prey alive, while species containing poisonous fangs are also to be found in this family. Here are included some that are being used in industrial pursuits. Oviparous species (those that lay their eggs) predominate, though the methods of laying these eggs and subsequent hatching vary. Viviparous species (those that bring forth the young alive) are also common. A knowledge of the skull, especially arrangements of head plates, and in particular dentition and the terminology of the scales, are provisions employed to classify this large family, many species of which look alike externally. The number of the abdominal and subcaudal plates, the coloration of a species and the locality where it was found are other important factors which may aid in identification and classification.

The Colubridæ are subdivided into three sections: (1) The Aglypha, which possess solid teeth, no grooved or perforated fangs and are harmless; (2) the Opisthoglypha, back-fanged snakes, containing one or more pairs of grooved venom-conducting fangs in the rear of the upper jaw (posterior maxillary teeth grooved). Though suspicious as possessing poisonous venom, the latter is but mildly poisonous to man, being mainly used by these snakes to benumb their prey, which are usually other snakes; (3) the Proteroglypha (front-fanged snakes with grooved teeth), which contain a pair of short, rigid, venom-conducting fangs in the *front* of the *upper* jaw (anterior maxillary teeth grooved or canaliculated). Here are to be found many of the most deadly poisonous snakes.

The Aglypha, we find, are divided into three subfamilies: (a) Acrochordinæ, which contain river snakes, usually ugly in appearance, possessing wart-like tubercular scales and found in the rivers of Southeastern Asia and Central America. They feed on fishes; (b) Colubrinæ, which contain most of the commonly found and typical harmless snakes; and (c) Rhachiodotinæ contains the egg-eating snake found in tropical and South Africa.

The Colubrine snakes include all types which display varied habits, marked differences in size, are usually harmless, but some species may become vicious and are capable of inflicting severe lacerations. The following are the important genera and species: Eutænia, the Striped, Garter or Ribbon Snakes, are the most abundant of North American snakes and are commonly found in United States and Mexico. They multiply rapidly, giving birth to forty or fifty, and as

many as seventy-five young in a litter. They are viviparous. They thrive upon earthworms, frogs, toads, etc., and are cunningly secretive. They are harmless and inoffensive. They are of no value to the agriculturist as they feed solely on cold-blooded prey.

Tropidonotus, or the Common Water Snakes, found abundantly in temperate and tropical parts of the Eastern and Western Hemispheres are usually found near water. When cornered they may display a vicious temper and are often mistaken for poisonous snakes and known accordingly under the misleading title of water "moccasins." All species in this genus do not produce venom. They eat fish, frogs, toads, and other cold-blooded prey. Their average size is 3 feet and their bodies are proportionately stout. They are usually found sunning on derelict timber, on branches of trees overhanging lakes, streams, etc., and they may be found associated with the deadly water moccasin. They are easily frightened and in times of danger they drop or retreat into the water, being agile swimmers.

The genus Lycondon contains few species which are of interest, in that many of its members resemble the much dreaded poisonous snakes belonging to the genus Bungarus (the Kraits).

Zamenis or the Racers are oviparous vicious snakes, species of which are numerous and found in the Old and New World. They are usually of large size, very agile, and hunt in the open for their prey, usually small rodents, frogs, birds and other young snakes. The important Old World species is the India Rat Snake. In this country two important species are the Coach-Whip Snake and especially the American Black Snake or Black Racer. Black Snakes are found in areas from the Atlantic to the Pacific. Their smooth, satiny black scales impart a gun-barrel lustre to the back. They are easily recognized. It is unfortunate that this species should be generally feared and usually slaughtered, for it is of considerable value in fields and woods in destroying rodents. If surprised this snake will disappear quickly, due to its agility, but if cornered, it will fight viciously, and dart for about half the length of the body at the aggressor. The worst that can happen if it should bite is a few scratches on the skin. It is not a constrictor.

Coluber—the Rat Snakes—Members here are generally powerful constrictors and feed upon warm-blooded prey, especially mammals and birds. They are usually powerfully built, possess flat abdomens, glossy scales, large eyes and average 5 feet in length. They inhabit the temperate and tropical parts of the Old and New World. The

most widely distributed species in this country is the Pilot Black Snake found from the Atlantic to the Mississippi and from Massachusetts to Florida. It was thought that this snake warns and leads the slower moving venomous rattlesnake and the copperhead to safety and thus the name Pilot. This theory which is incorrect arose from the fact that this snake is found frequently, especially in the North, in the same localities with rattlesnakes and copperheads. Then we have other species, especially those known commonly as the "Chicken Snake" (a misleading popular title), the "Corn Snake" and the most attractive of the European Colubers, the "Leopard Snake." Many species of this genus will prey upon domestic poultry, especially young chickens, and their eggs.

Pituophis—the Bull Snakes—Species in this genus possess short-pointed snouts and in this country are perhaps the largest of North American harmless snakes. Due to a characteristic cartilaginous filament in the mouth, these snakes are capable of producing a loud, hissing sound. They are constrictors, usually oviparous, and feed upon warm-blooded prey. They are of great value to the agriculturist.

Heterodon is a genus of the Colubrinæ, containing many important species commonly known as the "Hog-nosed Snakes," "Blowing Adders" and "Flat-headed Adders" or "Sand Vipers." These species are found in North America, live entirely upon the ground, feeding mainly upon toads and occasionally on frogs. They are very strong in proportion to their size, which is never over 3 feet, look ugly and formidable but lack any constrictive powers. They are harmless, cannot and will not bite, though they hiss loudly and assume the most threatening attitudes, even dilating their necks, and in a way imitating the Cobras of the Old World. The hissing breath is not poisonous and the threatening attitude is in reality a display of an ingenious, harmless bluff so as to frighten away an attacker.

The genus Ophibolus contains several species found mainly in United States, Mexico and Central America. The species in this country are known as the "King Snakes," the best known member and typical form being the "Common King Snake or Chain Snake." Though gentle in their attitude toward man, who employs them as pets, and though rarely attacking members of the same genus, they display a surprisingly cannibalistic attitude towards other kinds of snakes and lizards. They can live for years without food, will eat dead animals, though they are fond of small rodents and young birds.

Their range of sizes is from 1 to 6 feet in length. They are apparently immune to the venom of all species of poisonous snakes, except to that of the Cobras. A ridiculous and fabulous story circulates concerning several species of this genus which are known as the Milk Snakes found in various parts of our country and which are alleged to steal milk from cows. Members in this genus are among those snakes that "mimic" the Coral Snakes.

The Ring-necked Snakes, embracing a few species and placed in the genus Diadophis and the Scarlet Snake placed in the genus Cemophora, are found in this country. The Scarlet Snake, a constrictor, feeding on mice, small snakes and lizards, is a beautiful serpent and is apt to be mistaken by the novice for the poisonous Coral Snake, but the differences in the pattern design aid in identification.

The Rainbow or Mud Snake, belonging to the genus Abaster, and the Red-bellied Snakes placed in the genus Farancia, are other members of the Colubrinæ that occur in the southeastern part of this country. These are beautiful reptiles, 4 to 6 feet in length, lead a subterraneous life and are harmless. The negro folks have circulated a ridiculous story about the Red-bellied Snake taking its tail in its mouth and rolling along at a rapid speed, resulting in the naming of this snake as the Hoop Snake.

The other subfamily of Aglypha is Rhachiodontinæ, which contains one important species found in South Africa, the Egg-eating Snake. The food of this species is restricted almost entirely to eggs.

The back-fanged snakes or those grouped in the section or division known as the Opisthoglypha were at one time classed with the innocuous snakes. They possess poison-glands and fangs, but these are reversed or found in different regions as compared with the position where they are found in the important venomous snakes. The fangs, either one or several in number, are furrowed or grooved and are situated in the extreme rear of the upper jaw. Due to this position of the fangs, a dangerous bite can only be inflicted upon humans when the serpent gets a hard grip with its jaw, and this rarely happens as the Opisthoglypha snakes are shy. They are, however, very active and quick, killing their prey rapidly after first benumbing their victim with their venom which seems to affect mainly the nerves. This cosmopolitan division contains many genera and species mainly found in warm areas and in the tropics. Here we find the Poisonous River Snakes (Homalopsinæ) which feed on fish, other members of the subfamily Dipsadomorphinæ which live on trees and may be

brought into our midst by shipments of fruit coming from areas inhabited by these serpents and then others are terrestrial, subterraneous or semi-aquatic.

The front-fanged snakes belonging to the section or division Proteroglypha of the Colubridæ are the most deadly species of snakes known. Two important subfamilies are recognized: (1) Hydrophinæ or the Sea Snakes, which are strictly marine species, possessing strongly compressed, oar-shaped tails; and (2) Elapinæ, the Elapine or land snakes, which are terrestrial species representing the most deadly of the poisonous snakes, and which possess cylindrical tails.

There are several genera and many species of poisonous Sea Snakes which occur mainly in the waters of the Old World, particularly the Indian Ocean and in the tropical parts of the Pacific. The only important member of this group found in the New World, and which is also found in the Old World, is the Yellow-bellied Sea Snake which occurs in Central and tropical South America.

The Elapine Snake include the Cobras and their many allies in the Old World and the Coral Snakes in the New World. Australia, containing a predominance of poisonous snakes, abounds in these Elapine species. Perhaps the most interesting of the Elapinæ are the Cobras (genus, Naja) which contain many species widely distributed over Asia and Africa. The Cobras more so than any of the other snakes, and in particular the Spectacled Cobra or Cobra-de-Capello, known scientifically as Naja tripudians, have acquired notoriety and are the cause of a considerable loss of life. The Cobras are known for the habit of spreading the neck into a "Hood" when angered. This characteristic is especially marked with the Spectacled Cobras when at the same time they rear the anterior portions of their bodies, usually a third the length from the ground, and when spreading the "hood," disclose a weird marking on the distended skin which might be likened to a pair of large, glaring eyes covered with a figure similar to a pair of spectacles. The fangs situated on the forward part of the jaw are short, stout, and always erect. Cobras are hostile, vicious serpents, strike quickly forward and downward after first hurling itself into its characteristic upright position. The action usually accompanied by a sharp hiss results in the ejection of the venom which usually produces fatality, death resulting from the production of a general paralysis. Cobras feed on small rodents, birds and eggs, which are swallowed entire. The average size of a large Spectacled Cobra is 2 inches in diameter by 6 to 6 and a half feet in length. A

smaller and less spectacular Cobra than the India or Spectacled Cobra is the Egyptian Cobra, Naja haje, which either this species or the Egyptian viper, Cerastes cornutus, is the Asp which is concerned in the suicide of Cleopatra. The most deadly of the Cobras and of Old World serpents is the King Cobra or Hamadryas, Naja bungarus. These are slender serpents, reaching a length even as great as 12 feet, are oviparous and look anything but vicious or poisonous. They seem to possess a marked degree of intelligence. They are cannibalistic.

Closely allied to the Cobras is the genus Bungarus, which contains the dreaded poisonous semi-nocturnal snakes known as Kraits. The common species are found in India and adjacent areas and cause a loss of many lives. They, however, bite only when molested and usually do not retreat when attacked but hide their heads under the coil of their body. We also find in the same subfamily the Ringhals of South Africa (Sepedon hæmachates), which has a habit of "spitting" its venom when cornered or angry. The Mambas, belonging to the genus Dendraspis, found in tropical and South Africa, are semi-arboreal snakes. One species found here is an active, bold serpent, and like the King Cobra is said to pursue one when disturbed. The Death Adder (Acanthophis antarcticus), one of the important poisonous snakes found in Australia, is one of the most dreaded of the Elapine snakes.

There are other genera closely related to the Cobras or Hooded Snakes, but most of these are found in countries other than the New World. The one important genus representing the Elapinæ in the New World is the genus Micrurus (Elaps), occurring in Southern United States, Mexico, Central America and tropical South America. These are the Coral Snakes, which when examined quickly resemble many harmless snakes, but if carefully examined one will find that the poisonous Coral Snakes display single black rings bordered with a pair of yellow rings while the harmless snakes which appear almost similar possess single yellow rings bordered with a pair of black rings. Species of Coral Snakes average about 3 feet in length, possess a cylindrical body, are secretive, addicted to burrowing habits, and are cannibalistic, feeding upon other species of snakes and lizards. Coral Snakes bite as do the Cobras, advancing their fangs in a chewing motion, but they strike on an object only when touched. Due to their short fangs, ordinary clothing is sufficient protection against the latter and the venom which passes through. The most important

species of Coral Snakes in this country is the Harlequin Snakes or Coral Snakes commonly found in Florida, Georgia and South Carolina. These snakes are usually found after heavy rains and are frequently dug up during ploughing.

Family—Amblycephalidæ—Leaving the Colubridæ and its several sections, subfamilies, many genera and large number of species, thus making this the largest family of the Ophidia, we come to the family Amblycephalidæ. The latter is composed of harmless snakes inhabiting Central and South America and Southeastern Asia. Known sometimes as the Chunk-headed Snakes, the members of this family seem to connect the Colubridæ to the Viperidæ, though they are more closely related to the former.

Family—Viperidæ—The thick-bodied, long-fanged, venomous snakes are placed in the family Viperidæ. These Viperine Snakes are the most specialized among snakes in the development of the poison apparatus. The family Viperidæ is divided into two subfamilies, the Viperinæ, the True Vipers, or the Vipers Proper found mainly in the Old World, and the Crotalinæ or Pit Vipers, found most frequently in the New World, but some species are distributed throughout the Old World.

The True Vipers are divided into nine genera containing many species found extensively over Europe, Africa and the greater part of Asia. The genus Vipera contains the type species. Here we find the Common Viper (Vipera berus), the only poisonous snake inhabiting the British Isles; Orsini's Viper (Vipera orsinii), found in the plains of Austria and Hungary and in the mountains of Italy and the adjacent Alps; and Russell's Viper (V. russelli) or Tic-polonga, found in India and the East Indies. The Common Viper, Vipera berus, the only poisonous snake found in Great Britain, is a rather small, pugnacious snake biting like most of the other Viperine snakes in a quick, lightning fashion. One of the common and most deadly snakes of India is V. russelli or Russell's Viper, a beautiful looking 4 to 5 foot reptile. This, like most of the other species of genus Vipera, hisses sharply and steadily with each intake and exhalation of the breath, the body in most instances rising and falling like a bellows. Members of the genus Bitis are restricted to Africa and though inert and sluggish, they are generally feared on account of their usually fatal bite. The important species are the Puff Adder (B. arietans), the Gaboon Viper (B. gabonica) and the Nose-horned Viper (B. nasicornis); and genus Cerastes contains two species found

in Northern Africa, Arabia and Palestine, C. cornutus, which is known as the Horned Viper because it contains a pair of large, erect, horn-like scales found above the eyes, and C. vipera, in which horns are always absent.

The Puff Adder, belonging to the genus Bitis (specifically Bitis arietans), is widely distributed in Africa. It is especially vociferous during its inhalation and exhalation, whence the name of Puff Adder. It is a villainous looking snake, possessing burrowing characteristics and feeds on small mammals. The Horned Viper or Asp, Cerastes cornutus, found in the northern desert region of Africa and Southern Asia, figures historically in the suicide of Cleopatra.

The Pit Vipers, subfamily Crotalinæ, are the ones which concern us in this country, for most of the poisonous snakes in United States are found listed here. The only others are the Coral Snakes, the Elapine Snakes, distantly related to the Cobras, which were mentioned previously. Every species in the several genera listed here are quickly recognized by the presence of a deep pit between the eye and nostril. The exact function of the pit is not known, but it does aid us in immediately identifying a Crotaline Snake. A unique group found in this subfamily and one which concerns us very much in this country is the Rattlesnakes possessing a remarkable caudal appendage. The snakes possessing a tail with a rattle belong to the genera Sistrurus and Crotalus. Practically every part of this country is inhabited by some species of rattlesnakes. The latter with the Water Moccasin or Cotton-mouth Snake and the Copperhead Snake belonging to this same subfamily, genus Agkistrodon (Ancistrodon), are the dangerous poisonous snakes we find in this country. It is, however, to be remembered that the poisonous snakes, including these last mentioned and the Elapine reptiles (Coral Snakes) in this country, are in the minority, being present in an amount of less than 15 per cent. of the total, the reptile life being comparatively large in this country.

The important species of the genus Ancistrodon is the Water Moccasin or Cotton-mouth Snake (A. piscivorus), which is found mainly in the swampy areas of the southeastern portion of the United States. This is a dull olive, semi-aquatic, pugnacious, irritable, ugly serpent possessing a stout body and averaging 4 to 5 feet in length. It feeds upon fish, frogs, birds, small mammals and other species of snakes for it is cannibalistic. The name "cotton-mouth" is due to the fact that when this serpent opens its mouth, the parts that are disclosed are white as cotton, this contrasting very noticeably with the

color of its body, which is rather dark or blackish. The Moccasin produces small broods of living young. Bites by these reptiles are not frequent, due to their semi-aquatic habits and also to the fact they generally attempt to slip away and escape and will only strike with their fangs when approached very closely or cornered.

Another species of this genus and one of the most beautifully colored pit vipers found in this country is the Copperhead Snake (Ancistrodon contortrix) (or Agkistrodon mokasen). This is not a large serpent. It is highly venomous and is usually found in the eastern and central portions of the country, though it also occurs frequently in extreme southern areas, especially in Texas. The Copperhead Snake is vicious, feeds on frogs, birds, small mammals and other species of snakes and is viviparous. Though the venom of this poisonous serpent is very powerful, being perhaps more deadly than the venom of other poisonous snakes, it is but infrequent that humans are inoculated with it by Copperhead Snakes as the latter are rarely aggressive. They will only strike when cornered or when one is within very close proximity and the comparatively small fangs and small amount of venom secreted may not always be capable of penetrating heavy clothing, etc.

The genus Lachesis or Bothrops contains many species found only in Central and South America and Southeastern Asia. None are found in this country. A strikingly colored, interesting and most terrible creature is a member of this genus found in Central and tropical South America known scientifically as Lachesis or Bothrops mutus and otherwise as the Bushmaster, Sirocucu or the Mapepire. It is the longest of the Pit Vipers, attaining a length of 12 feet. It is slender in comparison to its length and is very active. It is also interesting that this species in contrast to the other Crotaline Snakes is not viviparous but lays eggs. Another formidable member of this genus found in Central and tropical South America is the Fer-de-Lance (Lachesis lanceolatus or Bothrops atrox).

The two genera, Sistrurus and Crotalus, include the group of serpents known the country over as the Rattlesnakes. The appendage, the rattle, is the characteristic by which members of these genera are identified. The stories told about the function of the rattle, its purposes and indications and other fabulous assertions would require an evening's lecture in itself. Though it serves to warn intruders, this is perhaps incidental and probably not nature's intent for its presence. The segments of the rattle do not indicate the age of the serpent.

Many of these stories are fallacies. The true purpose is in reality not known and any apparent scientific explanation which is given is probably a theoretical assumption.

The rattle is composed of hollow segments of dry, horny skin each fitting loosely into one another. At birth, the rattle is represented merely by a button, the growth starts from the end of the tail proper and a new ring or segment growing larger and larger is uncovered each time the snake sheds its skin, until when the snake attains its full growth, all of the segments produced thereafter are of uniform size. The characteristic rattle appears among all species, and its presence is sufficient to warn one of the poisonous character of a snake.

The genus Sistrurus contains the Pigmy or Ground Rattlesnake (S. miliarius), a small, attractive reptile with a tiny rattle, found in the southeastern part of this country, and the Massasauga (S. catenatus), a somewhat larger species, found in the swampy regions of the Central and Southwestern States.

The typical rattlesnakes belong to the genus Crotalus, the species of which differ from those in genus Sistrurus by showing in most instances small, granular scales on top of the head. Members of this genus eat warm-blooded prey only, mammals and birds, while those in genus Sistrurus feed largely upon frogs. The important rattlesnakes in this country, members of this genus, are the Black-tailed Rattlesnakes; Banded or Timber Rattlesnakes, a beautiful reptile distributed far and wide over the country; the Diamond-back Rattlesnakes, the largest of rattlesnakes, the most deadly of North American poisonous serpents and possessing huge fangs and enormous poison glands; the Western Diamond or Texas Rattlesnakes, another large species of this genus; the Prairie Rattlesnakes, a moderate size reptile commonly found in the Plains; the Pacific Rattlesnakes; the Tiger Rattlesnakes, the White Rattlesnakes and others found in Mexico and other parts of the United States.

USES OF SNAKES Style—what hasn't been committed in thy name? Even the snakes have to do their bit so that milady may have adornments on one thing or another.

Startling as it may seem, it is nevertheless a fact that up until five years ago the skins of reptiles were not used commercially. We all perhaps remember having the harness worker fix some snake hide on our belts or other wearing apparel, but the secret of tanning reptile

leather for commercial purposes was only brought forth recently. Reptilian skins with their exotic beauty softened and kept permanently pliable, yet retaining the bizarre pattern marked by nature are now available for the designer to make snake shoes or to a less extent for ornamenting or trimming coats, purses, bags, gloves, pocketbooks, automobile and other upholstery, luggage, golf bags and sticks, canes, umbrellas, cigarette cases and lighters, handles of toilet articles and other accessories. It possesses the best of wearing qualities, durability, adaptability, beauty and at present, style has decreed its popularity. The use of snake skins is adapted also wherever light weight, but strong leather is desired.

The collection of snake skins for the production of hides is not necessary to be under the supervision of scientists or naturalists. The collection of these skins is organized in a way on the same basis as the rawhide business of other hides (calf, goat, sheepskin, etc.) is organized.

Not all of the different species of snake skins are suitable for commercial use; and just as with furs, other leathers and wool, not all species of these animals bearing the raw products are used. Climatic conditions and in some instances other factors influence the state of the pelt and its value to man. Perhaps of the several species of snakes, the Water Snakes are used in greater numbers, the Karung, a water snake of Java, Hindu China, Siam, Borneo, Batavia, and adjacent sections, supplying the largest volume. There are approximately one and a half millions of these snakes used in this country and in Europe in the tanning industry. Water Snakes are usually easy to catch, the species employed are generally non-poisonous and they are most popular due to the delicacy of their markings. The natives simply reach over the edge of the river bank and with lightning quickness, the slippery reptile is caught and thrust into a box or other suitable container. The next most desirable of the various snakes is the Python. This, though not poisonous, is very deadly, due to its constricting and crushing powers. It is, however, easy to catch a Python when once located, due to the fact that it has a weakness for fresh goat. A live goat or other suitable meat is tied near the location where the Python is found. The natives then retreat to a safe distance and after the Python has gorged itself with the fresh meat, it lies in a state of stupor. In this state it is caught and placed in a suitable container. The best Python skins are obtained from the jungles of India and Java and range in size from 8 to 30 or 35 feet in length. There

are approximately one-third the amount of these skins as compared to the skins of Water Snakes which are used annually. The Boa is also used mainly because its skin is generally cheaper. The latter, however, is not a desirable pattern. The Boas are imported from all of the Far East countries except Japan, Korea and Northern China. Some skins from Boas are also obtained from South America. Probably over 98 per cent. of the snake skins are Water Snakes, Pythons, and Boas. The skins from the Cobra, though a gorgeously marked snake, is employed but infrequently. The Buddhists consider this snake sacred and due to this religious prejudice the quantity of Cobra skins used is probably very small. New snake skins are coming on the market at all times. The jungles of the world and everywhere where snakes are to be found are being searched for snakes in which the skins reveal a pretty pattern and which would not be too small for general use. Snakes which are usually located in the deep sea by pearl fishermen and sponge divers and coming from the Far East have recently reached the market. The snake supply in this country is very limited. Probably not over 10,000 snakes are killed and cured annually and which skins are marketable as commercial products. And in temperate climates where civilized man is to be found in greater numbers one finds that the various snakes are becoming fewer in number. Snake skins are used in "upper" of the shoes, that is the top covering. They are difficult to tan and it was for this reason and not for the lack of appreciation that this industry remained undeveloped until science evolved a procedure of preserving reptile skins by tanning. The American tanned reptile seems to exceed in quality, finish and style possibilities so that the skins tanned in this country are apparently more in demand. This country, though more distant from the source of raw stock or raw product is, however, nearest to the source of demand and accordingly has taken the leadership in reptile tanning.

OTHER USES OF SNAKES

Various parts of the snake, and in particular its internal organs have been supposed by the credulous to possess peculiar virtues and accordingly employed in the production of salves, oils and other medicinal agents. Formerly it was a common occurrence to find that certain Indian tribes would poison the tips of their war-arrows with the venom of poisonous snakes (in this country rattlesnake venom was commonly used). Their use in ceremonials and among the charms of the medicine-man and by snake-charmers is well known.

SNAKES AS FOOD

Primitive man in the differentiation between a food and a drug probably ruled that which proved to be pleasing to the sight, palatable to the taste and non-injurious after consumption was a food, while that which was distasteful or unsightly, and especially that which proved harmful after consumption, was a drug. Snakes being unsightly or feared or due to religious and other prejudices were not adopted by many as a food. Yet testimony indicates that snakes can be made appetizing as a food just as frogs, and turtles and other closely related amphibians and reptiles. In fact, one individual who ate fried rattlesnake informed me that it tasted like chicken. Another states that it tastes like eel. Many people in foreign countries, primitive and others, with less inherited prejudice, do eat snakes. The Australians, the African bushmen and the Indians throughout the American tropics eat snakes (usually large snakes) whenever they can be obtained. It is also interesting to note that at our own Pennsylvania State College, the freshmen foresters, who spend six weeks at the end of their freshman year in a forestry camp, have had what they call a "rattlesnake feed." A rattlesnake is captured, fried, cut up into bits and each student has a taste. This comprises the so-called "rattlesnake feed" at State College concerning which all kinds of fallacious stories appear annually. In fact, Professor J. A. Ferguson, of the Department of Forestry, informs me that "these stories have grown to mammoth proportions and have been printed in England and Scotland with the statement that we furnished rattlesnakes to our students in lieu of meats."

To-day's dreams and imaginations may result in their realization to-morrow. So perhaps the dish of rattlesnake may some day come into its own as a food.

SNAKES OF VALUE TO THE FARMER

Until but recently and the prejudice is as yet entirely too common, farmers regarded snakes as their enemies. They little realize the economic value of the reptiles in destroying injurious mammals. An actual loss in money is suffered when misguided and thoughtless persons indulge in the killing of harmless and yet valuable snakes by disguising their act as a falsely superstitious hatred of snakes. When snakes are found congregated in fields, around grain, about barns, etc., the farmer immediately determines that they are useless or injurious to his crops and they immediately take measures to eradicate

the reptiles. Little do they realize that the presence of these snakes is instinctive in that they congregate where gophers, mice, rats, and ground squirrels are found. The latter gnawing animals damage the grain and cause considerable trouble and loss for the farmer. Take, for instance, the "bull snake," which can make its way into a narrow hole and trap the rodents in their subterranean homes. This and similar snakes are actually more effective natural enemies than the hawk and the fox, who have to wait for the appearance of the rodents above ground. If the foolish prejudice against harmless reptiles would not prevail the latter, if not destroyed, would destroy many of the rodents and thus aid in preserving the profits of the agriculturist. It would be an easy matter for an intelligent farmer to learn merely the differences in gross appearance between harmless and poisonous snakes if the latter were known to be found in his vicinity, and then allow the former which are frequently common to go unmolested.

SNAKES AS PETS

Reptiles and Amphibians have become popular in certain circles as pets. Lizards, snakes and horned toads in particular have been chosen. The reasons for employing snakes as pets are varied, but usually due to some eccentricity on the part of their owners.

SNAKE CHARMING

Is it an art? How do these Orientals and others perform their snake charming and seem to elicit swaying of the Cobra or other species of snakes to the tune of some weird music producing the so-called "snake dance"? All travelers in the Orient are familiar with the sight of the filthy, fat native who mumbles and whistles and beats a tambour or blows through his pungi (a bottle-shaped gourd with two bamboos or reeds inserted), emitting weird sounds or shrill-penetrating wheezes and whines, to which the Cobra wags its head, puffs its hood and lazily sways to the sibilancies. Charming performances are so common in various foreign countries that the natives and their children are by now accustomed to its sights, and they have also acquired an entirely different attitude toward reptiles in general. In fact, this difference in attitude can be almost regarded as a dividing line between Occident and Orient. Where most of our children are scared to death of snakes or at least they are repulsive to them and they will put up a brave front when they may find themselves close to them, the Oriental

child is in most instances not afraid of even a Cobra. In fact, a fitting test of bravery is for a child to play the Cobra a tune while the parents and others look on. In many instances the "snake charmer" is possessed with a thorough knowledge of snakes, being familiar with their important characteristics and methods of handling, so that in few instances one will find that the snakes have not been defanged. In few instances, one may find that a Snake Charmer may have submitted himself to graduated inoculations of the venom from the same species of snake with which he is working, so that by producing antivenin in his system, he may remain immune for a given interval of time and therefore even if bitten, he will show no outward effects. It is not an infrequent occurrence, however, to find that in many instances the snakes have had their fangs removed. This does not of course render such snakes entirely harmless. The poison still flows from the wounds remaining by the extraction of the fangs, but the likelihood is that snakes not containing the latter won't bite, and if they do, such poisonous venom will not gain access into the circulation unless some lacerations or cuts were produced. If it is desired to make the snake permanently harmless, the entire poison apparatus is removed by peeling the plate of the bone. The teeth and glands are fastened from the roof of the mouth to the latter. The swaying of the snake's body is not due to any interest in the music, but is due to the fact that the performer sways his body to keep in time with the music and the snake sways in a similar manner, altering its position to be always in aim to strike its aggressor. The snake in all probability does not hear the sound and yet as indicated appears to be affected by the vibration.

SNAKE DANCE This is a dance of a religious character performed by the Moqui Hopi Indians in Arizona. The dance is said to have been performed by this tribe of Indians, in the same manner and in the same place, ever since the middle of the sixteenth century. The rite includes the bearing of as many as 100 live snakes in the dance and each of these is borne by the dancers while dancing. Toward the end of the dance the snakes are carried in armfuls by the Indian men, and placed on the ground within a circle of sacred meal in front of a sacred rock. Here to the accompaniment of prayers and chants the serpents are sprinkled with the sacred cornmeal until the whole writhing, wriggling mass is completely covered by the meal. The dance concludes by the Indian men grasping each

as many snakes as he can hold and dashing down a steep incline at top speed. At its foot the snakes are liberated and scattered in every direction.

An interesting and detailed account giving also a summary statement of previous accounts of Hopi Snake Ceremonies is to be found in the Anthropological Series (Publication 66, Vol. III, No. 3), of the Field Columbian Museum, in which Dr. George A. Dorsey and H. R. Voth relate their experience during the witnessing of the performance of these rituals in one of the Hopi villages. Scientists who have been present at snake dances given by the Hopi Indians of Arizona speak of their fearlessness in the handling of rattlesnakes, from which neither the fangs nor the poison glands are removed. There appears to be no natural immunity among these Indians to the rattlesnake venom, and though they lay remarkable claims to the antidotal value of a decoction made from the stems and leaves of a plant (which is only known to few of the natives and kept a secret), the latter from scientific experiments recently conducted does not seem to possess the value claimed for it.

ENEMIES OF SNAKES

In the jungle, where snakes multiply rapidly, they are kept down by natural enemies, most of which are not to be found in inhabited areas, where man upsets the balance of nature. It is these natural enemies which aid in keeping the proper balance of life.

Man is in reality the snake's arch enemy. In environments where humans settle, road-building, together with the motor car, account for the death of many thousands of snakes. The vehicles usually run over the snakes as they wander to the roadway coaxed there by the rays of the sun. In the general operation of agriculture we find other factors contributing to the death of many more. Thus we have the mower, binder, disc and plow and other modern farm implements used in the fields, killing off reptiles. The burning off of stubble and brush and the draining and cultivating of low lands aid to diminish the numbers of snakes. In addition to this, there are entirely too many farmers, hikers, and in fact, most all humans who in the foolish prejudice against harmless and frequently useful reptiles seem to think that the only kind of snake worthwhile viewing is a dead snake with the result that every snake as soon as observed is killed by any type of an implement which may be at hand. Aside from man and indirectly the implements he employs in his operations, the greatest foe

of snakes is the snake itself, as many species are cannibalistic. The great King Cobra feeds entirely upon snakes, but is itself more dangerous than any he might destroy. However, the king snake and its allies in our country and the musurana in Brazil devour poisonous snakes, they themselves being harmless and inoffensive. Then we have the red-tailed hawk, known also as the big hen-hawk, the skunks, and probably pigs. It is said that domestic animals as dogs and cats can be taught to kill snakes. In addition to the mongoose, the European hedgehog and some of the large ground cuckoos, certain birds prey on snakes, usually the harmless variety. The cursorial hawk, the secretary bird of South Africa, the honey buzzard, some heavy-billed storks and ibises, the emu and the jaburi eat snakes. Certain spiders, toads and frogs devour snakes. It is interesting to see the toad eat a snake as it crawls along, for the toad will only eat moving objects.

GENERAL CHARACTERISTICS OF SNAKES. STRUCTURE

Snakes are scaly forms characterized as possessing long, narrow, cylindrical bodies devoid of limbs. The scales cover the entire head and body and their disposition is used as an important guide in the classification of snakes. In some few species (certain Boas and Pythons) tiny vestiges of hind-limbs are to be detected in the form of two or three small bones which support a small horny claw. Fore-limbs are never represented even by vestiges. The bodies usually taper towards the posterior end. It is startling to see how wide the mouth of a snake can be stretched. The mouth is capable of being opened widely due to the free articulation of the lower jaws, as the halves (rami) of the latter are not solidly united or fused together at the chin (symphysis) as is found among the lizards, but they are connected by elastic fibres or ligaments and are therefore capable of being moved or separated. The whole palatal apparatus is so articulated or connected to the skull as to permit of free movement. The great distention of the mouth and throat made possible by this freedom of movement enables snakes to swallow objects entire and of large bulk. Movable eyelids and a tympanum (middle ear cavity) are absent. It is due to the former characteristic that one hears the statement made that snakes sleep with their eyes open. A sleeping serpent may therefore be awakened by seeing a sudden movement. The absence of eyelids, leaving the eyes glaring, accounts for the fixed stare possessed by serpents. Some observers believe that the latter may be the cause of the horror or dislike which humans have for

snakes. The pupil is usually round but in the Boas and other species, it appears as a mere vertical slit. The eyes usually capable of considerable movement are covered with a transparent or glossy appearing cap, which is shed at each casting of the skin. Though there are no external ears, the sense of hearing is present in all snakes, but it is not very good, and surely not so fine as the charmers would make us believe that snakes can differentiate between the different sounds made by their so-called music. The tongue in snakes, usually of a dark color or even black, is very long and slender or thread-like, and bifid or forked at the end. It is highly sensitive and is used chiefly as a tactile organ (organ of touch). The tongue cannot and does not "sting" as some are inclined to believe. It is said that snakes possess a remarkably acute sense of smell.

The vertebræ are very numerous, each vertebra hollow in front and convex posteriorly being connected with the adjoining one by free ball-and-socket joints, horizontal connecting projections preventing twisting though admitting of considerable vertical and horizontal play. Due to this arrangement and the concavo-convex centra. the backbone of a snake possesses considerable strength and extraordinary flexibility. The vertebræ bear ribs which may exceed many hundred pairs in number. A sternum (breast bone) and episternum, present in lizards, are absent in snakes. The ribs, therefore, cannot be attached or fastened at their inferior ends to a breast bone but they are attached to opposite ends of a series of large scales or scutes found upon the abdomen. The whole forms a mechanism for locomotion in the absence of legs and serves the purpose of a foot. It is with this arrangement that snakes crawl and wriggle and they have brought their method of progression to a high degree of perfection. The snake moves along by a series of horizontal undulations (waving motions), brought about by the contractions of the muscles inserted into the ribs, any inequalities on the surface of the ground serving as fulcra against which the free posterior edges of the ventral shields (and which are connected with the ends of the ribs) are enabled to act. It is on this account that snakes are sometimes known as "rib walkers." Snakes therefore cannot and do not travel on a smooth surface. They cannot and do not move in vertical curves and climb trees in spiral fashion, which is the artistic but erroneous mode of representation of the movements of snakes. Like any twisted object it can glide, but its undulations are always horizontal. Snakes cannot and do not jump completely off the ground when attacking. Some snakes can

raise the anterior part of their body and even move while in this position, but this is only a fraction rarely more than one-third of the total length which is erect or does not have contact with the ground, etc. Most snakes though extremely active and alert in their movements do not keep in motion for any length of time.

INTERNAL STRUCTURE

There are but few differences between the internal structure of snakes and other reptiles. The digestive system consists of salivary glands, a distensible gullet, stomach and intestines which terminates in an outlet transverse in structure. Snakes drink large quantities of water and also possess remarkable powers of fasting for long periods of time. Snakes like all reptiles have an elongated trachea, the wall of which is supported by numerous cartilaginous rings. The anterior portion is dilated to form the larynx. The trachea divides posteriorly into two branches forming two bronchi, right and left, one passing to each lung. The lungs are fusiform sacs, the inner lining of which may be raised up into a network of delicate ridges, having the appearance of a honeycomb. The lungs, ovaries and other paired or symmetrical organs exhibit an abortive condition or reduction in size of one of the pairs. In the snakes an abortion of the left lung is apparent. The heart consists of a sinus venosus, a thin-walled chamber into which the large veins open, returning the blood from the body. From this, an aperture, guarded by two valves, leads to the right auricle. There are two distinct auricles, the right receiving the venous blood and the left receiving the oxygenated blood brought from the lungs by the pulmonary veins. An important difference between the heart of the reptile and that of the amphibians is in the structure of the ventricle. In amphibians the ventricle is usually divided into right and left portions. In most reptiles, including snakes, the ventricular-muscular partition though developed, does not completely close off the left-hand portion of the cavity of the ventricle from the right, so that we say that the heart of reptiles consists of three chambers, two auricles and a ventricle. The left-hand portion of the ventricle is much the larger and is further imperfectly divided into two parts.

REPRODUCTION AND AGE

The sexes are perfectly distinguishable. Snakes either lay eggs (oviparous) or produce their young alive (viviparous). Most snakes and a greater proportion of snakes than lizards are viviparous, the ova usually under-

going development in the interior of the oviduct, and the young reaching the exterior in the completely formed condition. Snake eggs usually having a parchment-like covering are generally oval in shape, and vary in size from a fraction of an inch to several inches in length. Eggs are usually deposited in loose earth, moist sand, decaying barks or wood—railway embankments are ideal places—and here the sun soon begins to hatch them. Parent snakes do not as a rule guard the eggs during this period, which in most instances takes four to eight weeks, hatching generally occurring in the late summer or early fall. Some species like the Pythons lay their eggs and coil about them until they are hatched. These eggs incubate among the folds of their bodies and hatch in about two months. The number of eggs laid or living young produced vary with the different species and differences in the size of those in the same species will likewise affect the numbers of offspring. As few as six and as many as seventy or more eggs or young may be produced. The snakes that are hatched, as well as the young produced alive by other species, show marked variations in size varying from a few inches to several feet in length. There is generally but one brood a year. The young of poisonous snakes possess perfectly formed venom-conducting fangs and glands and they are just as dangerous in proportion to their size as their parents. The age to which snakes live can only be approximated. If we are led to judge by their rate of growth in captivity, a 30-foot snake would probably approximate 100 years.

TEETH AND FANGS OF SNAKES

The jaws are provided with solid, elongated, single, thorn-like or sharp-pointed teeth, which are usually strongly recurved so that they appear like sharp hooks. All the teeth may be of the same character throughout and they are not lodged in distinct sockets but ossified to the jaws. They are never permanent and are capable of being renewed. Their function is not to masticate but to hold the prey and prevent it slipping from the mouth while being swallowed. These teeth differ in various species mainly in the fact that they may be stouter or more slender, shorter or longer, or there may be fewer or show an increase in number. These characteristics and others as slight differences in structure are valuable aids in the classification of the Ophidians.

In the non-venomous snakes, the jaws and palate bear in continuous rows teeth as just described, but teeth are rarely developed on the

premaxillæ. In the venomous snakes many or few of the maxillary teeth assume the character of poison-fangs. The latter, most frequently larger than the ordinary teeth and varying from one-quarter to one inch in length, are grooved or perforated by a canal (as in a hypodermic needle), for the passage of the duct of the poison-gland. The structure of the venom-conducting tooth or fang is not the same in all poisonous snakes. In the Vipers, the maxilla bears a single, large curved poison-fang with small reserve fangs at the base. The large poison-fang is capable of being rotated through a considerable angle and moved from a nearly horizontal position, in which it lies along the roof of the mouth embedded in the folds of the mucous membrane to a nearly vertical one, when the snake opens its mouth to strike its prey. In the venomous Colubrine Snakes, the poison-fangs are either the most anterior or the most posterior of a considerable range of maxillary teeth. Fangs are frequently lost, but these are quickly replaced by several spares which lie in a fold of tissue behind the working fang. When the latter is lost, one of these spares moves forward and in a short time becomes firmly cemented into the cavity of the lost tooth. The fangs themselves are shed at given intervals (about four times annually), but before it is loosened or lost, a new fang already grown in alongside of the old one becomes connected with the poison-gland.

When a venomous snake strikes, the poison is pressed out from the poison-gland by the contraction of the masseter (constrictor muscle), one of the muscles which raises the lower jaw. This is forced along a duct leading to the aperture entering the poison-fang and then injected into the wound made by the fang. The introduction of the venom by the fangs into the tissues or muscles is comparable to an injection of a poisonous agent given beneath the layers of the skin or into the muscles by a hypodermic needle to which is attached a syringe and to which pressure is applied.

POISON GLANDS

These are modified glands found in venomous snakes. They correspond to the parotid salivary glands of the higher animals and are situated on the cheeks behind the eyes, lying above the lip margin. The gland opens into a tubular duct, this terminating in a fringed membranous mouth. In passing the fang this duct is connected to a sinus at the base or upper end of the fang.

STRIKE BY POISON FANGS

Venom does not flow freely from the fangs of poisonous snakes except during the act of striking. This is due to the fact that normally the opening between the duct and the base of the fang is compressed by a sheath, or a fold of mucous membrane. The introduction of venom from the poison-glands through the excretory ducts into the canals of the fangs is accomplished by the compression of a ligament. The compression of the poison-gland and the forcing out of this venomous fluid is accomplished by the same movement, which through a combined action of several muscles also opens the mouth and presses the horizontal pterygoid bones forward to erect the maxillaries with their fangs. The ejection of venom is a voluntary act and unless desired these muscles are not normally contracted sufficiently to force the poison from the glands.

The several varieties of poisonous snakes may display different actions when striking. The Pit Vipers literally stab forward, frequently with a terrific force and a lightning speed. The fangs are driven deep, quickly withdrawn and the snake draws back to a position of defense or to await the death of its victim. The Elapine Snakes with their small immovable fangs do not stab, but bite and chew for several seconds with the view of letting its less effective, shorter fangs become embedded as deeply as possible and thus enable the venom to get into the deeper tissues and exert its effect.

If the object to be struck is beyond the reach of the venomous serpent, the entire stroke may be completed without touching the object of attack. At most the snake strikes about one-half its length when delivering an accurately aimed blow. It is only after an exceedingly large amount of excitement that a poison snake may strike a distance equal to more than one-half and rarely over two-thirds of its length. It never springs bodily, that is, its whole length, at any object it is about to attack. It usually strikes a much shorter distance in proportion to its length.

In case the object of the snake's anger is too close, the most frequent occurrence is to find that the fangs have not penetrated deeply if at all as when striking, the fangs were not fully erect.

OCCURRENCE AND HABITS

Reptiles were more widespread in ancient days than they are now. It is probable that Central Asia was the region where most members of this class were to be found and from here they spread by the various facilities available for migration.

Reptiles, and snakes in particular, are confined in large numbers to the tropical and semi-tropical areas. They are also found in the temperate regions, but in the latter where the winter and freezing weather prevail for long periods of time, only small numbers are observed. The number of species of individuals steadily decrease in the cooler temperature zones but few being found in real cold regions. They range much farther in the latter areas than do lizards. Most all countries in the tropical and semi-tropical areas harbor snakes with the exception of few isolated islands as the Azores and the Hawaiian Islands. Just as with their general distribution so in their mode of life and habits, marked variations are to be found. Snakes are found everywhere, in the hills and mountainous regions, deserts, grassy plains, fields of all kinds, sand, on trees, in forests, in fresh water, in the sea, etc., and so we have:

Burrowing or Subterraneous Snakes, which live underground and are but infrequently found on the surface. They burrow into the ground like worms and feed chiefly on invertebrate animals, especially ants, and none are poisonous. They tend to become eyeless, even tailless, and they possess smooth instead of overlapping scales.

Ground or Terrestrial Snakes comprise the largest number of the several species and are the types which we observe more frequently. The majority of snakes in this group are non-poisonous, though the greatest number of all of the poisonous snakes are to be found here. Due to their habits, and especially during feeding when they seek seclusion so as to assimilate food, snakes are not commonly observed in as large numbers as actually present.

Tree or Arboreal Snakes pass the greater part of their existence on trees and are capable of climbing bushes, trees, etc. They usually have slender compressed bodies and long tails and therefore appear whip-like. Their coloration usually resembles that of their surroundings. They feed on animals leading an arboreal life. Some species are poisonous. Certain species of Arboreal or Tree Snakes are known as "Flying Snakes," so named from their habits of parachuting down to the ground from the top of the tree where they reside.

Freshwater or Semi-aquatic Snakes live in or frequent fresh waters. They are agile swimmers. They feed on fish, frogs, and other aquatic animals. They are viviparous and most all species are non-poisonous.

Sea, Marine and persistently Aquatic Snakes are unable to move on land. They are viviparous, feed on fishes and most species are poisonous.

Snakes are the most stationary of all vertebrates, rarely changing a locality if the proper food and shelter is present. Some species may be limited to a sharply restricted environment or local area while others adapt themselves to wide ranges of territory.

FOOD FOR SNAKES

The food of snakes varies considerably. Other than mentioned, the terrestrial snakes display different fondness for various foods. Some snakes prefer a species of snake other than its own (cannibalistic) or they eat lizards. Small snakes eat slugs, earthworms, frogs, toads, or insects as beetles, crickets, caterpillars, grasshoppers and grubs. Larger snakes feed on mice, rats, ground squirrels, rabbits, possums, rodents, birds, and in the case of Pythons, etc., on chickens, and mammals even as large as pigs.

The Pythons and Boas kill their prey by constriction, winding their body closely around it and drawing the coils tightly till the victim is crushed or asphyxiated. Some other non-venomous snakes kill with bites of their numerous sharp teeth. The venomous snakes sometimes when the prey is a small and weak animal, swallow it alive, but they usually kill it with the venom of their poison-fangs.

Snakes don't feed often, though in some few instances this may be daily. Weather conditions and the size of its previous meal are factors which influence the frequency of feeding. A Boa kept in Paris holds the record of having fasted forty-nine months. Most all snakes eat in the same manner. They pull their flexible head over their prey, each of the four jaws catching hold by turn as they push forward one at a time. The process of swallowing is a more or less mechanical one. It is interesting to observe that a snake almost always starts its meal on the head end of its prey.

INTELLIGENCE OF SNAKES

The brain of reptiles is more highly organized than that of amphibia. We know of several habits and actions of snakes, either when attacked or when living normally, which apparently simulate degrees of intelligence. There are some habits and gestures in certain species of snakes, which we know as mimicry, and which serve a helpful purpose for the snake by usually making it look more dangerous than it really is. Their

cunningness when attacked is known to all. We must frankly admit that we don't know whether these and other actions are merely instinctive or governed by acts of reasoning, though herpetologists are inclined to credit snakes with some reasoning powers, based upon their own experiences and that of the observations in the several Zoological parks where snakes are in captivity. Experiences related by many about the King Cobra are interesting and suggest an ability to reason. Perhaps during this age of the intelligence test with the interest taken recently in the study of reptiles, the snakes, like the automobile driver, the army recruit, and the college student will have an intelligence test especially prepared for them at the serpentarium or at some laboratory. Then perhaps we will know more as to their attributes and intelligence, their instincts and capacity for action, their efficiency and their organization and as to whether certain actions concerning which we are familiar are instinctive or whether they are the products of a certain amount of reasoning which perhaps might be classed as intelligence.

SIZE

Variations in size as in structure is more marked among snakes than among the other reptiles. Burrowing snakes having the thickness of a goose quill and a length of from 3 to 5 inches are to be found, and on the other hand, there are species of Pythons from 20 to 30 feet or the Anaconda, monarch of the Boas, credited with a length of 40 feet and higher with a proportionate girth.

HIBERNATION

Snakes are extremely sensitive to cold. They do not possess feathers, fur, or the protective coat of a mammal, and thus they cannot protect themselves against cold weather so as to remain active when the latter prevails. They must therefore hibernate or remain inactive for long periods during the cold months. In real cold climates, their only chance of survival is to burrow beneath the frost line and remain there until cold weather is over. If they don't possess burrowing ability they die. In temperate climates, snakes spend the winter sleep in burrowing beneath the ground for a short distance. Others may find their way in cavities in trees, while the rattlesnakes and moccasins and other species of snakes find their way into the cracks and crevices of rocks, in which they hibernate. Snakes do not hibernate in warm climates. Here, on the other hand, we do hear of certain species which may succumb due to intense heat.

Hibernation of serpents in cold areas results in a most interesting observation. Many of the same species congregate in considerable numbers at specific "dens" or places. They come from great distances each year to this same area, guided probably by the same instinct that results in the migration of a flock of birds.

SHEDDING SKINS

All vertebrates shed their skins. The process may be gradual and almost unnoticeable in some mammals. Healthy and well-nourished snakes shed in one piece their entire skin, which is thin and overlays their scaly covering. Along with this epidermis in the one piece is to be found that covering the cornea of the eye, so that this is shed whole. The outer layer of the epidermis during shedding as it is cast entire is turned inside out in the process. The frequency of this shedding varies in different species and in the same individual at different ages and is also dependent upon other factors as weather conditions, health, etc. Ordinarily in temperate regions, at least two sloughs are cast in a season, one in the spring and another in the late summer. In warm climates, this event may take place at intervals of two months apart. Before the shedding commences the color of the serpent fades and the eyes become white or milky due to the separation of the outer layer of epidermis from the cornea. This results in an impaired vision and has given rise to various nonsensical superstitious and mythical stories.

PROTECTIVE DEVICES OF SNAKES

Many species of snakes seem to be endowed with elaborate or spectacular devices which in most cases apparently serve the sole function of frightening away an aggressor. Whether these developments are employed between snakes for purposes of signalling each other or whether they may serve the snake in any other capacity is not definitely known.

The Cobras are well known for the manner in which they spread out or distend the sides of the neck and head when disturbed or irritated. In the Cobra de Capello or the "Bespectacled Cobra," one will find that there are several loosely articulated ribs, which are moved by muscles found on the sides of the neck. These interior ribs of the neck expand or are drawn forward by the muscles so that the anterior part of the body or the region behind the head spreads out to a marked degree, giving the appearance of an overhanging arch or hood. On the middle of the latter, posterior to the eyes, is a greenish

yellow marking, resembling the rim of a pair of spectacles, thus the name "Bespectacled Cobra." When alarmed, the Cobra raises the anterior part of its body, so as to attempt to stand erect, expands its hood and waving its body from side to side it is made to appear much more threatening than it would otherwise be. Apart from the Cobras, there is the Mamba, a poisonous arboreal snake, and several species of harmless snakes, the Theletornis of the Congo, and our own the Blow Adder or the Hog-nosed Snake, which are able to raise the anterior part of their bodies vertically and expand their necks in a manner imitating somewhat the dreaded Cobras. These harmless snakes create considerable fear among the uninitiated.

The vibration of the tip of the tail is common among several species of snakes. The use of the rattler and the spitting of venom as means of frightening away an aggressor will be mentioned. The habit of curling up like a ball to protect its head is common among many species of snakes, especially among some of the Boas. The hissing by snakes in which the sound is even as loud as that of escaping steam prevails among those species having a large lung capacity and possessing powerful muscles. Horns on eyelids, and in rarer instances on the nose, spines on the tail, and different devices possessed by burrowing snakes to dig up the sand and sink out of sight are to be found on different species of snakes. The emission of secretions which possess an unpleasant odor is practiced by few species of snakes and this actually serves as a protective device, inasmuch as one is not prone to handle these specimens.

The power of maneuvering the muscular body so as to kill their prey is possessed by the boas, pythons and other species as the chicken snake and the pilot black snake. The crushing powers are greatest at the hindermost part of large constrictors, as the pythons.

POISONOUS SNAKES

It is, of course, the venomous or poisonous snakes which really play the most important role in the relation of reptiles to man and the higher animals. In some instances, and in particular in tropical and semi-tropical countries, the problem of ridding environments of poisonous snakes is a unique and important problem. Even here in our own country, we must be prepared to cope with these creatures. Without taking into consideration that poisonous snakes are to be found in mountainous and swampy areas, on farms and in sparsely populated districts, there are instances where especially due to the facilities of travel these

creatures may be found literally at our door. At such times, a differentiation as to whether the reptile is poisonous or non-poisonous will be of considerable value. For instance, I have several recent newspaper clippings before me. One gives a report of a merchant in our own city finding in his cellar a snake six feet in length and as thick as a man's arm. After an investigation, it was concluded that the reptile arrived with a shipment of fruit and found its way into the cellar through a break in a partition which divided his basement from that of a fruit store next door. Another clipping from a well-known national weekly known for the accuracy of its contents, tells of a baseball fielder at Chapel Hill, N. C., who ran to retrieve a home run and as he leaned to pick up the ball from a tuft of grass, a snake bit him severely in the hand and POISONED him. Still another gives an account of a brown and white snake, 15 feet long and weighing about 75 pounds, which was captured in a third-story apartment on Eighth Avenue, in New York City. The capture required a squad of six policemen, who struggled for one hour before it was finally subdued and removed. I have before me a copy of a report from Police Commissioner Joseph A. Warren, of New York City, relating the details of this capture and investigation together with a copy of a report from Dr. Raymond Ditmars, the world renowned herpetologist from the New York Zoological Society, who identified the specimen as a member of the Pythons, a non-poisonous snake. This investigation also revealed that the snake escaped from a cage next door, where it is kept and used in an act in various theatres. The snake entered by way of the fire-escape. Many of the Zoological parks receive Copperheads and Rattlesnakes sent in by individuals who catch them practically within city limits.

Without citing other cases which I have before me, you may nevertheless observe that this problem may frequently reach close to home. And then remember that our prairies become farms and ranches and finally these become settled more thickly and the right of men to live and possess the land being greater than that of the animals it seems inevitable that the fauna of this area must leave, die or be killed. Until this happens and the possibility of its arising is far off, we will have poisonous snakes about us, and when hiking, hunting, camping or working or even fishing in these areas, one must be on the lookout for poisonous reptiles. The degree of danger from a bite depends not only upon the species which has inflicted the wound, but on the size of the particular species, the amount of poison de-

posited, and the place where the wound was made. The mortality in children bitten by poisonous snakes is greater than that of adults, for the same amount of poison is deposited by the venomous snake whether a child or an adult is bitten. Like all poisons, the deathly effect of the venom is in proportion to the body weight; an amount which when injected into a large body or that of an adult may not prove fatal would, however, in the same dose, kill a child.

Excluding the Sea Snakes, which are merely Water Cobras, and all are venomous, there are about 250 other species of snakes which have a well-developed poison apparatus. About one-third of this number may be disregarded, due to their small size or rarity, leaving the remainder as the total number of poisonous species which are of some concern to humans and higher animals.

Accurate statistics are not available from most of the countries infested. In European countries, where there are many poisonous species, and where records are not kept, there seems to be but few fatalities. In Africa, while the poisonous species are abundant and even dangerous, they seem to remain confined to the Jungles or sparsely settled areas, so that there seems to be no great loss of human life. Here also statistics are not available. The regions where most fatalities occur are in the order of the greatest losses: India, Southern Brazil and Australia. In Central America and North America there are more casualties than there used to be and only recently campaigns have been started which promise to result in a marked reduction of poisonous snakes and in the saving of all lives bitten by any of the latter in these areas.

The loss of live stock and higher animals other than man can only be guessed at, as no reliable statistics are available, but there is no doubt that this runs up into the millions of dollars annually. You must remember that all of the natural habits of all varieties of poisonous, and even many of the non-poisonous snakes, may not be known. For obvious reasons, which you can surmise, all of them may not be known, as close studies cannot always be made under natural conditions. Not all types of snakes can be kept in captivity and then again their actions under such conditions are most frequently modified or changed. For instance, there is a little data available concerning diseases of snakes except when in captivity, where various diseases, especially mouth infections, are known.

POISONOUS SEA SNAKES

The Sea Snakes or Marine Serpents comprise over fifty species of several genera belonging to the Hydrophiinæ. They are all strictly marine, very poisonous, the most deadly of snakes, viviparous, of various sizes, and striking coloration. They are provided with a rudder-like tail and nostrils on top of the head closing with valves. They abound in the Indian Ocean, and in all warm and tropical waters except the Atlantic, being mainly confined to the Old World. A single species, the Yellow-bellied Sea Snake, found in the Old World, is also common in the Bay of Panama and in the tropical waters off the west coast of Mexico, Central and South America. Though rarely met when swimming, this species is dreaded by fishermen, who frequently haul up specimens in their nets.

POISONOUS SNAKES IN INDIA

Tropical India is rich both in the number and different kinds of snakes. Though accurate statistics are uncertain, it has been estimated that approximately 20,000 natives die annually in India from the effects of bites by poisonous snakes, this in spite of all attempts to exterminate these creatures. One of the reasons accounting for this great loss is that the poisonous snakes lie in the roadways so as to be baked by the sun. They are prone to lie there even for days at a stretch. The Indian folks have a habit of walking on these roads by night to get the cooler breezes. Usually barefooted and therefore unprotected, they come across these snakes and are bitten. In most cases, capture of the snake is impossible, so that identification of the species in turn is out of the question. Chance for a cure is likewise markedly reduced, for even though antivenin may be available, it is impossible to know whether to give antivenin for the prevalent species of Cobra Snakes, the antivenin for the prevalent members of genus Bungarus or the Kraits or the antivenin for Russell's Viper, as each one is specific and Cobra antivenin will be valueless for the venom of other snakes and vice versa.

The Cobras seem to occupy in the minds of laymen the position embodying the deadliest of evils. Yet strange enough, the two species of this genus found in India, Naja tripudians (Spectacled Cobra) and Naja bungarus (King Cobra) do not cause as many deaths as do the various species of Bungarus, especially the dreaded Krait, Bungarus cœruleus, and the deadly viper, Vipera russellii, known also as Tic Polonga, Baboia or Russell's Viper. The Kraits and Russell's Viper

lie more quiet, are not as active and less inclined to move out of the way than the Cobras. The Cobra is held sacred in many sections of India. They have even come to lead a semi-domesticated existence, and it is not an uncommon occurrence to find one or even several about a village temple.

POISONOUS SNAKES IN AUSTRALIA

Australia is one country where the poisonous snakes are in the majority. Many species are small and rare. Most of the dangerous Australian snakes are members of the several genera belonging to the Elapinæ, the same subfamily to which the Cobras and their allies and the American Coral Snakes belong. The Death Adder (Acanthophis antarcticus), the Tiger Snake (Brachyaspis [Hoplocephalus] curtus), the Brown Snake (Diemenia superciliosa) and the Black Snake (Pseudechis porphyriacus) are some of the dangerous serpents found here.

POISONOUS SNAKES IN TROPICAL AMERICA AND BRAZIL

Poisonous snakes abound in Brazil. The latter was the first country to attack this problem scientifically and systematically, obtaining results that are worth while. Accurate statistics are not available from Northern Brazil, so that results that are reported are obtained after using as a basis the statistics of the State of Sao Paulo in Southern Brazil, where the government established in 1899 the Seropathic Institute of Butantan. Where twenty years ago there was on an average of 5000 humans (leaving out of account farm animals) killed annually in Brazil, last year with a population of four times as great, less than sixty deaths occurred. This is due partly to the propaganda on behalf of the wearing of shoes, systematic destruction of the pests, and due to the use of the antivenin by those bitten.

There are approximately twenty-three species of poisonous snakes found in Brazil, most of them belonging to the genus Lachesis (Bothrops), pit vipers belonging to the subfamily Crotalinæ. Here we find the Fer-de-lance (Bothrops atrox) (Lachesis lanceolatus) and that terrible dangerous creature the Sirocucu, Surucucu, Mapepiré or the Bushmaster, the largest of the Crotaline serpents and the only important species of the latter which lays eggs.

In tropical America, poisonous snakes are not commonly observed. The problem of their control seems to concern mainly industrial and commercial organizations who employ men in jungle labor.

It is here when the jungle is being cleared or plantations are being cleaned, that poisonous snakes appear and are a menace to the barefooted laborers. The Fer-de-lance, known also as the Barba Amarilla, Terciopelo, Jararacá, Mapepiré balsayn is perhaps the most common species of the many species of pit vipers to be found here and does most of the harm. The South American Rattlesnake Crotalus terrificus and the Bushmaster are found but infrequently. The many species of Coral Snakes, though present and extremely dangerous, are generally of little concern, as they possess a mild disposition.

There is a possibility that in the near future, deaths caused by snake bites in the tropical Americas will be a rarity, for a comprehensive anti-snake-bite campaign has been under way for the past four years in an organization which has an experimental research station and serpentarium at Tela, Honduras. In this organization the following cooperate, the United Fruit Co., Dr. Thomas Barbour through the Harvard Museum of Comparative Zoology, and Dr. Afranio do Amaral through the Antivenin Institute of America.

POISONOUS SNAKES IN NORTH AMERICA

From a scientific standpoint, we have to regard all snakes as poisonous if they yield venom which is capable of producing some toxic action in contact with the body tissues of humans and animals. Practically, however, some of these apparent poisonous reptiles are not as dangerous as they appear, because of the fact that though they secrete venom they but rarely attack man, and when they do they are unable to inject the poison deep enough into the tissues to exert any serious effects.

There are nineteen different species of poisonous snakes in North America and they are included in two groups. One is the proteroglyphs (front-fanged snakes with grooved teeth), a section of the Colubridæ, and the other is the solenoglyphs (highest stage evolution of poisonous fang and possessing maxillary teeth which embrace a longitudinal tubular duct), comprising mainly the pit vipers found in the subfamily Crotalinæ, family Viperidæ. The proteroglyphs include two subfamilies, the Poisonous Sea Snakes (Hydrophiinæ) and the Elapine Snakes (Elapinæ). The Elapine Snakes include the Cobras and their allies and the Coral Snakes. There are no Cobras or Cobra-like snakes in North America, but the closely related Coral Snakes are to be found in this hemisphere. Of the many species of Coral Snakes only two are found in this country.

In the United States proper, practically every state is inhabited by venomous snakes with the exception probably of Maine and New Hampshire. In the other states, when we consider the convenience of travel, we can literally state that poisonous snakes are in "our midst." It is interesting to note that in the northern states, though poisonous snakes are plentiful, they don't seem to be so vicious and possess a milder temper.

CORAL SNAKES The two species of Coral Snakes, the Harlequin Snake (Micrurus [Elaps] fulvius) and the Sonoran Coral Snake (Micrurus [Elaps] euryxanthus) are frequently confused with non-poisonous snakes. The main point of differentiation, of course, lies in the fact that the Coral Snakes possess a pair of short, stout, longitudinally grooved fangs (therefore known as proteroglyphs), one on each side, in the upper and front part of the mouth.

Micrurus fulvius, "Harlequin Coral Snake."

Each fang is rigid in its position, does not fold against the roof of the mouth and in fact is practically devoid of any motion. After some experience in the observation of the gross appearance of snakes, one will also find that the loreal, a plate found on each side of the head of most harmless snakes is lacking among the members of the Coral Snakes.

The poisonous Coral Snakes, so called because of the presence of broad, bright, coral red rings, are of moderate size, possessing a cylindrical body, each broad crimson marking being followed by a broad black marking, and both separated by a narrower yellow ring. The blunt head is as wide as the neck and therefore not distinct from it. They have a comparatively small mouth and possess a rather amiable temperament. Their length is rarely over 2½ or 3 feet. The Harlequin Snake or the common Coral Snake is found in humid places

from Northern North Carolina to Florida and westward through the Gulf States through Mexico and thence into Central America. It may occasionally be found in the Mississippi Valley as far north as the lower borders of Ohio. The Sonoran Coral Snake is much smaller and is not found as frequently as the other species. It is found in the Southwest, between the Rocky Mountains and the Colorado River, mainly in California, Central and Southern Arizona, New Mexico and Sonora, Mexico. Both species are oviparous, feed on snakes and lizards, and like all species of this genus they are of burrowing habits. They may be found under the ground, hiding under decaying logs, and come forth for food, and are seen in large numbers after heavy rains.

It is a common occurrence to find that these two species are mistaken for different varieties of harmless snakes, especially the following: Scarlet Snake (Cemophora cocconea), Scarlet Kingsnake (Lampropeltis elapsoides), Milk Snake (Ophibolus doliatus), Western Milk Snake (Ophibolus doliatus Gentilus), Arizona King Snake (Ophibolus zonatus), etc. Though most of these species of harmless snakes have rings possessing the same colors, the disposition of these rings is different and when once recognized, it becomes a simple matter to distinguish between the poisonous and harmless snakes. The yellow rings of the poisonous snakes always border the black rings, while among the harmless snakes there are two pairs of black rings bordering a yellow one. The bands of color with the poisonous snakes completely encircle the body, while in many of the harmless imitators the abdomen is white or blotched.

Due to the secretive nature of these poisonous Coral Snakes and due to the fact that the latter do not bite unless stepped on or annoyed, bites by these reptiles occur but infrequently.

THE PIT VIPERS The Pit Vipers belonging to the subfamily Crotalinæ (family Viperidæ) are solenoglyph snakes and are so named due to the presence in all species of a small deep pit or cavity in the loreal region just before the eye, in other words, a hole is found on each side of the snout between the eye and the nostril. This is never found in the other snakes. The pit itself is heavily innervated, but the exact function of this cavity is unknown. It, however, serves as a valuable and constant guide in identification, for the presence of a pit marks a snake as a poisonous reptile. The fangs are very long and are provided with an elongated orifice, hollow as in a hypodermic

needle. They are situated one on each side in the upper and front part of the mouth, and though rigidly fastened to the maxillary bones, they move with the latter, which are but loosely attached to the skull and very closely connected with powerful muscles. Each fang is connected with a gland, situated behind the eye and which contains the venom. The following genera are listed in this pitted group:

Agkistrodon (Ancistrodon), which contains the important Copperhead Snake (A. mokasen or A. contortrix), and the Cotton-mouth or Water Moccasin (A. piscivorus), the two important poisonous snakes found in this country; Lachesis (Bothrops) containing species found chiefly in Central and South America and none in North America. The Fer-de-lance, the Bushmaster and closely allied species are listed here. Sistrurus, the Pigmy or Dwarf Rattlesnakes, containing two important species, and genus Crotalus, the Rattlesnakes, containing thirteen important species of poisonous snakes found in this country are the other important genera. In all, this makes a total of seventeen important species of Pit Vipers or Crotaline Snakes which, with the two important species of Coral Snakes, make a total of nineteen species of poisonous snakes found in this country.

GENUS AGKISTRODON (Ancistrodon)

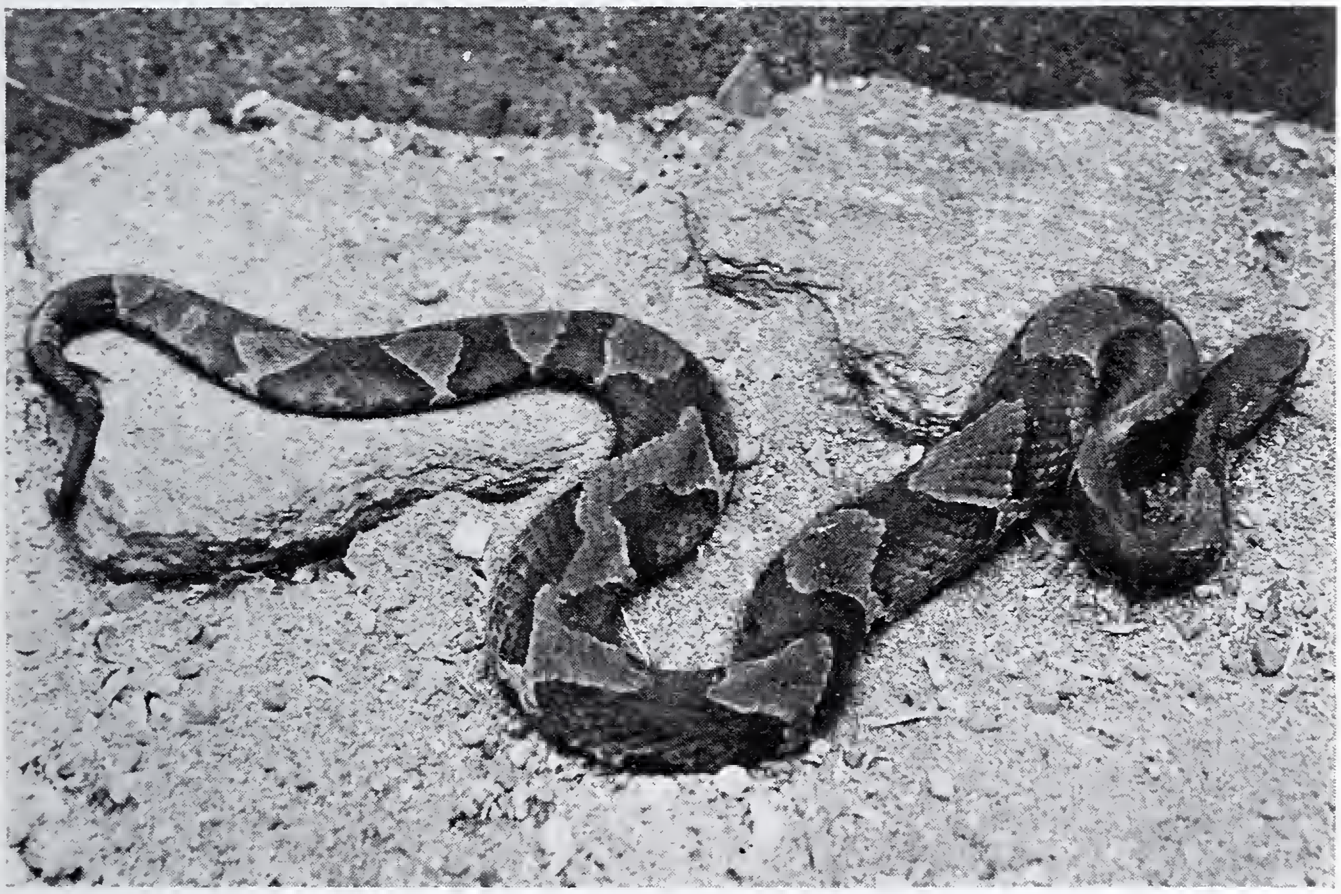
In addition to the characteristics mentioned previously concerning this and the other genera of Pit Vipers, the additional information which follows will be of value.

The Copperhead and Cotton-mouth Moccasin, members of genus Agkistrodon, possess head plates which are covered with large shields. This may be similar to that observed in some of the harmless snakes, but the latter are easily distinguished from the poisonous serpents due to the presence in the latter of the pit and the elliptical pupil of the eye as compared to the round pupil present in the eye of the harmless snakes. By their head plates, they appear as do members of the genus Sistrurus, also containing pit vipers, but the latter contains a tail with rattle not present among species of Agkistrodon.

The Water Moccasin or Cotton-mouth Snake is large and stout, in fact, it is one of the largest poisonous snakes found in this country. It possesses an obscure color pattern in dull olive with wide, black transverse bands and a head which is very distinct from the neck. It is found in swampy areas or even in water, especially in the Southeastern and Gulf States, into Eastern Texas, and is a frequent visitor in rice fields. It may also be found in those states bordering the Mis-

sissippi River and its tributaries extending northward to Southern Illinois and Indiana. Due to its semi-aquatic habits, bites from the Water Moccasin are not of frequent occurrence. Surprised suddenly, this snake generally draws back its head, opens its mouth and glares in hostile fashion. It may strike at once, but as is more often the case, it quickly overcomes its first start of surprise and will attempt to slip away and escape.

Agkistrodon mokasen (Ancistrodon contortrix) is frequently known also as the Copperhead Snake, Highland Moccasin, Deaf Adder, Pilot Snake, Chunkhead, Rattlesnake Pilot, Pilot Snake and



Agkistrodon mokasen, "Copperhead."

Poplar Leaf. It is said that when pregnant a large number of females will at times twine themselves together, which accounts for the name "contortrix. It is pale, hazel brown, possessing large cross-bands of rich reddish-brown, which are narrow on the back and very wide on the sides. The head paler in color than the rest of the body usually displays a coppery tinge, thus the popular name of Copperhead. This serpent, averaging three feet in length, inhabits the eastern and central portions of this country, generally from Massachusetts to Northern Florida, thence westward, reaching from Illinois to Texas. It is found mainly in hilly and rocky areas in high and dry ground, though it may

be found near streams. The fangs of this species, as well as that of the Water Moccasin, are rather small in proportion to the size of these snakes. The Copperhead is a dangerous poisonous snake, but it may

Agkistrodon piscivorus, "Cotton-mouth Moccasin."

not cause considerable annoyance, because of the fact that it is not aggressive, will always attempt to glide away and will only strike when approached closely or caught at close quarters and escape is impossible. The Copperhead ejects but a small amount of venom, but the

latter is very poisonous. Of the 601 cases of snake bites reported in this country during 1928, 167, or almost 28 per cent. of them, were caused by Copperheads.

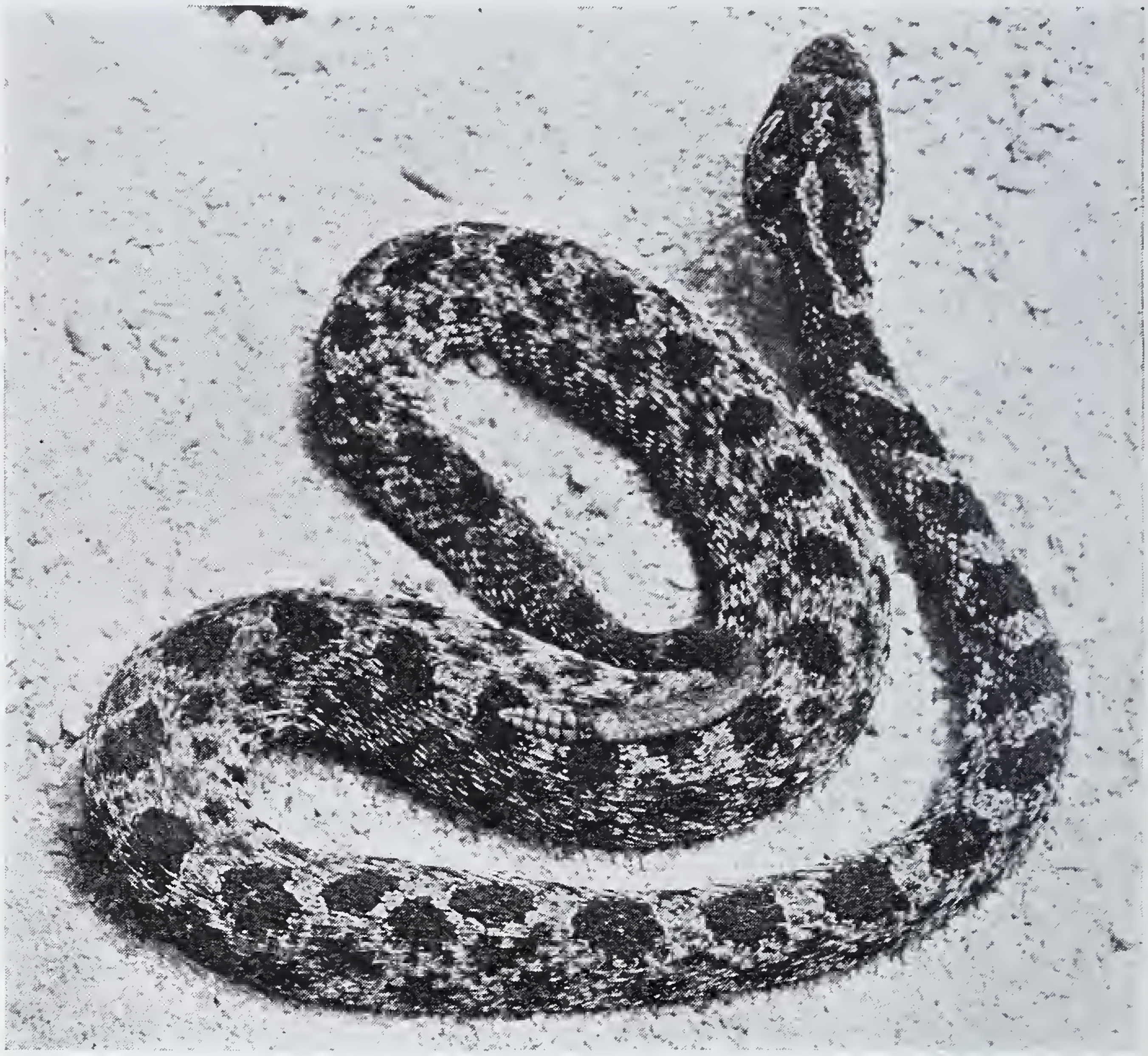
RATTLESNAKES The Rattlesnakes are the most important of the poisonous Pit Vipers found in this country. As a group they are also very interesting and attract much attention due to their colors, habits and actions, and especially due to the characteristic horny rattle appended to the tail, by the presence of which species of Rattlesnakes are immediately recognized. The particular or exact species is immaterial. As long as the caudal appendage the rattle is present, one should know at once that such a snake is poisonous and dangerous. The Rattlesnakes are divided into two genera, Sistrurus, Pigmy or Dwarf Rattlesnakes, and Crotalus, the Rattlesnakes.

GENUS SISTRURUS The Pigmy Rattlesnakes are distinguished from the other rattlers by the fact that the tops of their heads are covered with large, symmetrical shields, while in the rattlers the head tops are covered with scales. The head top arrangement with shields is also observed in many of the non-poisonous snakes, but the latter do not possess the characteristic pit and rattle present in these poisonous snakes. Only two important species, the Massasauga and the Pigmy Rattler, are of any concern in this country. The Massasauga is represented by two races:

(1) Sistrurus catenatus (Massasauga) and Sistrurus catenatus variety edwardsii (Edward's Massasauga). The common ground color in the former is grayish-brown, with large brownish black blotches on the back and a series of smaller blotches on each side of the body. This variety averaging about two feet in length, is found in the swampy regions ranging from Western New York through Southern Ontario and Southern Michigan to Kansas. Edward's Massasauga possesses a much paler color and smaller spots on the back. The rows of scales are a few less in number, but otherwise it resembles the typical Massasauga. It is not quite as partial to damp places and is found in Western Kansas, on through Oklahoma, Western Texas, Southeastern Arizona and through Northeastern Mexico.

Sistrurus miliarius, the Pigmy Rattler, also called Southern Pigmy Rattlesnake and by the popular but misleading name "Ground Rattlesnake" or "Florida Ground Rattlesnake," is a much smaller snake than the Massasauga. It possesses a dark ashy gray color with large black blotches and is found in dry ground among leaves or in

grass, distributed from Southeastern North Carolina to and throughout Florida, west along the coastal region of the Gulf of Mexico to Western Texas and Oklahoma, and northward through the valleys of the Mississippi River and its tributaries to Arkansas and Southern Missouri. The Sistrurus ravus, a third species, found in the lowlands of Eastern Mexico, shows about the same habits as the Massasauga.



Sistrurus miliarius, "Pigmy or Ground Rattler."

Owing to the diminutive size of the Pigmy Rattler and the Massasauga, the amount of venom secreted by them is usually small. They are accordingly the least formidable of the North American poisonous snakes.

GENUS CROTALUS
The Rattlesnakes (Proper)

The species of this genus of Pit Vipers do not have the head top covered with shields but with small granular scales. There are approximately fifteen distinct species and several varieties found in this country, but only thirteen species are of importance. The latter are

distinguished from each other by one or more of the following characteristics: differences in color and markings, variations in size, and presence or absence of horns over the eyes. It will be impossible to consider here technical differences. All that will be presented are the scientific and common names of the important species, statements of their ranges and some general characteristics.

Crotalus adamanteus—The Diamond-back Rattler is the largest of the Rattlesnakes, reaching a length of from six to eight feet. It possesses huge fangs with a large opening at the tips and enormous poison glands. It is found about swamps in the area extending from Southern North Carolina to and throughout Florida and on many of the keys and thence westward to the Mississippi River. The action of the venom of this species is very severe, causing considerable annoyance if death does not result. This is one species that but infrequently glides away if disturbed. It is perhaps the most courageous of North American serpents. Their body colors blend with the vegetation, so that they are at times observed only with difficulty. They are viviparous, and though feeding on all rodents, their favorite food is wild rabbits.

Crotalus atrox, the western Diamond Rattlesnake, averages about 5 to 7 feet in length. It is found in dry (sandy, desert) areas, rocky places, and in agricultural districts, its range extending from Texas to Arizona and California and south into Mexico and Lower California.

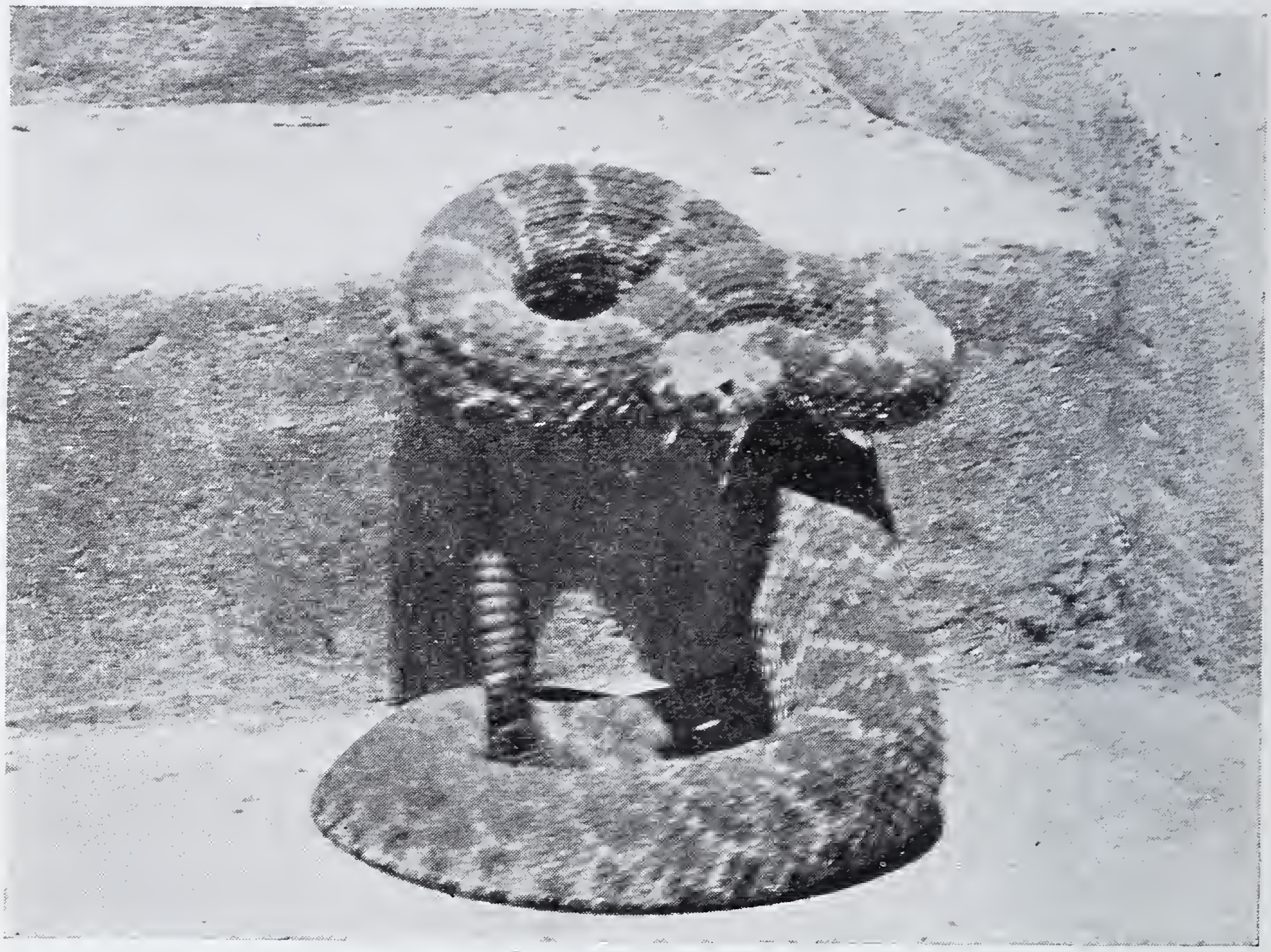
Crotalus cerastes—the Horned Rattlesnake or Sidewinner is one of the smallest members of this genus and is readily distinguished from the other Rattlesnakes by the prominent horn-like process over the eyes, which is in reality an elongation of the upper eye-shield (supraocular). This species is found in the sands of the desert areas of Arizona, Southern Nevada, Eastern and Southern California and Southern Utah.

Crotalus confluentus—the Prairie Rattler is a commonly found vicious reptile of moderate size. It is a typical snake of the prairies and is found in the region of the Great Plains from Southern Canada to Texas and west to a little beyond the Rocky Mountains. It feeds on all kinds of small rodents and its habits of prowling into burrows to devour any young has been responsible for the incredible tale of the closer relations existing between the prairie dog and this rattler.

Crotalus exsul, known as the Red Rattler or Red Diamond Rattlesnake, is a handsome snake of fair size, averaging close to 5 feet.

The color as well as the markings are employed to distinguish between this and other species of rattlers, especially the Western Diamond-back Rattler, to which it is closely related. It feeds on rodents and is found in rocky places, usually about cactus groves, and its range extends from Southern California into Mexico, Lower California and the islands of the Gulf of California.

Crotalus horridus, known as the Banded or Timber Rattlesnake, the Black Rattler and Canebrake Rattlesnake, is one of the commonly



Crotalus atrox, "Western Diamond Rattlesnake" (showing position for striking).

found species of the Rattlesnakes. Its range is extensive being found over the northeastern states, thence south to the northern portion of Florida and west to the Great Plains. It occurs most frequently on mountain ledges or in the crevices of rocks and in timbered or woody and hilly regions. This species is not very irritable, and prefers flight to combat. Like all Rattlesnakes this species is viviparous and feeds on warm-blooded prey, usually all sorts of rodents, but occasionally birds.

Crotalus leipidus, the Green Rattler, is the smallest species of this genus and is found in mountainous areas. Though rare, its range

extends from Western Texas, through Southern New Mexico and Arizona and the adjacent territory in Mexico.

Crotalus mitchelii, known as the Bleached Rattler, Pallid Rattlesnake, the White Rattlesnake, or Mitchel's Rattlesnake, is frequently mistaken for other species which it resembles. It exhibits a wide variety of coloration. This species is found mainly in rocky places, and around cactus groves and all kinds of thorny shrubs and its range is from Arizona to Southeastern California and Lower California.

Crotalus molossus, the Black-tailed Rattlesnake, which is readily identified because of the uniform jet-black of the tail, is of moderate size and is found around rocky ledges, its range extending from Western Texas to Southern Arizona. It is also found in the highlands of Northern Mexico.

Crotalus oreganus, known as the Pacific and Black Rattlesnake and in some areas even as the Black-Diamond or Diamond-back Rattlesnake and erroneously called Crotalus lucifer, is similar in many ways to the Prairie Rattlesnake. This species may show marked variations in coloration. It is found in mountainous and timber districts all over the West Coast from British Columbia to Southern California and east to Western Idaho, Nevada and Arizona.

Crotalus triseriatus, the Spotted Rattler, incorrectly known as Crotalus pricei, is a small species of Rattlesnake found in the mountainous areas of Southern Arizona and the central plateau of Mexico.

Crotalus tigris, the Tiger Rattlesnake, is found in the mountainous areas of the extreme southwest. It is probably not a very vicious species, and seldom attains a length of more than three and a half feet.

Crotalus willardi is another small species of rattlesnake found in the Santa Rita Mountain region of Arizona, and Northern Mexico.

SNAKE PROTECTION PRECAUTIONARY MEASURES AGAINST AND CONTROL OF SNAKES

When hunting, hiking or fishing or working in fields and plantations, observe where you walk and where you put your hands. If you are visiting areas where poisonous snakes are known to abound, protect your hands with gloves and wear leather leggins, or better still, rubber boots specially constructed with a shank and several layers of canvas. Frequently a pair of leather puttees beside the shoes will be sufficient protection. Don't pitch a tent in the vicinity of rocky ledges, swampy areas, or where tall grass is plentiful, but use a clean site. If you find that you are to sleep in this tent

more than one night, arrange to hang your bedding or clothing or keep them wrapped or well covered, preferably in trunks, and it would be best to shake or brush them before using again. Remember that in almost three-fourths of recorded cases of snake bites the wound is in the lower extremities, leg or foot, and in only one-fourth, or most of remainder, is it in the upper extremities, especially the hand.

If a building in a rural district or other area becomes infested or there is the possibility that it may become infested, it is best to see that all windows and doors and areas under porches are screened, and especially those doors and windows in the basement or cellar. All holes in the foundation, floor, walls, window-sills, doors and fireplaces should be filled in with cement or any suitable filling material or even sealed tightly with board or metal. Where all other measures fail, a permanent concrete moat will exclude all snakes. Those working or walking in fields should never go barefooted.

ERADICATION OF SNAKES

It rarely happens that snakes infest thickly populated districts in such numbers that they become a nuisance. Where few are observed and their presence is not desired, clubbing or shooting is the most satisfactory method of getting rid of them. If they are present in large numbers in a building or home and the latter can be closed or sealed conveniently, then the best procedure for eradication is to employ hydrocyanic acid gas fumigation. Due to the deadly nature of this gas, this technique should be used only by one experienced in this method of fumigation.

If outlying districts of any inhabited community become infested with snakes and especially poisonous snakes, it is best to try and find the habitats of the latter, which are usually nearby, and here most of them can be found and killed.

Poisonous snakes are one of man's oldest and deadliest enemies. We have progressively exterminated or tamed wild beasts, insect pests, and other menaces to human life, but this native species of death-producing wild creature has been allowed to take its death toll without any concerted effort on our part to stop its propagation, obtain remedies specific to neutralize its poison or to take effective steps to stamp it out. Only recently has the warfare, assisted by modern scientific methods, gained momentum.

In rural districts and on the farm it would be best to familiarize oneself with the methods of differentiation between the poisonous and non-poisonous, valuable species of snakes and see that the measures

employed in eradication are directed only against the former and not against the latter. Mice and rats, gophers, ground squirrels, moles, possums, and chipmunks, as well as young rabbits which interfere with the agriculturists by destroying their crops, are attacked by many snakes. Even on golf courses, where moles may disfigure greens, snakes are of value for the destruction of these pests. It is, therefore, advisable to see useful snakes should be allowed to proliferate in these environments and they should be given the opportunity to benefit man. Occasionally some species are found devastating poultry yards or fish ponds, so that measures are at times necessary for their destruction.

The offer of bounties as one of the methods of getting the layman interested in killing undesirable snakes in any environment may be tried, but this method of reducing their numbers is open to many objections. There is always present the danger that some people will import or obtain the desired snakes from distant or adjacent communities so as to receive the reward offered for each specimen. The introduction of the snake's natural enemies in an infested area is also dangerous unless one can be chosen which, when it will reduce the number of snakes, can itself then be gotten rid of, or if prevalent, it will not act as a nuisance. For there is always the possibility that this enemy of the snake may destroy other desirable animals or plants after it has exterminated the snake. Such, for instance, is the case with the mongoose. Yet there is a possibility that the European hedgehog or the skunk may prove to be the desirable natural enemy to employ. There is also a possibility that where poisonous snakes predominate in an area, harmless and inoffensive but cannibalistic species of snakes may be introduced to kill these undesirable invaders. The king snake and the musurana are typical examples. Yet, on the other hand, raising animals that feed on snakes always brings up other problems and is a method that usually does not succeed in practice, while the results of trying to get harmless snakes to feed on and replace poisonous snakes are not satisfactory.

Poisonous baits and traps are valueless in any program for the eradication of snakes. The complete obliteration of snakes in any large territory seems to be an almost impossible task, and accordingly we must be prepared at all times to treat bites by snakes so as to protect against the effects of their poisons.

WHAT TO DO WHEN BITTEN

When bitten by a snake, if possible, *kill or catch the snake that did the biting,* or if this is impossible, a careful or casual description of the snake may aid in the identification of the species. Knowledge of the fauna, and especially varieties of poisonous snakes apt to be present in any locality, is of great importance.

Just as it is necessary to capture a dog when bitten so as to find out if the animal has rabies, so one should attempt to find out whether the snake that did the biting is poisonous or non-poisonous. In the case of the snake, the identification is fortunately much easier than in the case of rabid animals. Such identification will enable one to avoid death or at least a considerable loss of time, discomfort, worry, money, etc. If the snake is a non-poisonous species, then no treatment is necessary, other than a local application of iodine or any similar disinfectant so as to prevent the slight wound from becoming infected.

If the snake that did the biting was a poisonous snake, then it might be necessary to identify the particular species. Just as in the treatment of gangrene we prepare and employ an antitoxin (antitoxic serum) which is specific for the neutralization of the toxin produced by the causative agent of gangrene and in tetanus or lockjaw, tetanus antitoxin is employed to neutralize the toxin produced by the tetanus bacillus (which causes lockjaw), so specific antivenins (antivenomic sera) are necessary in the treatment of bites by venomous snakes. In other words, antivenin for Cobra venom is useful for the treatment of bites of Cobra but not other snakes. The antiserum or antivenin is specific for the treatment of the venom from which it was prepared. The tendency today is to prepare a polyvalent antivenin (one made from the venoms of different species of snakes) which will counteract the effects of all venoms from poisonous reptiles. It seems impractical or impossible to prepare a polyvalent antivenin specific for venoms of all poisonous serpents found in the world, but a polyvalent antiserum or antivenin specific for most of the poisonous reptiles in a given locality is possible and is available. An antivenin to counteract the effects of all poisonous snakes in Brazil is available, being produced by the Brazilian government at the Seropathic Institute of Butantan, near the City of Sao Paulo, in the state of Sao Paulo. Brazil. Dr. Amaral, through the Antivenin Institute of America, with headquarters in Philadelphia, has produced polyvalent antivenin which is effective against the venoms of the principal poisonous serpents of the Crotalidæ. This includes the Rattlesnakes, Copperhead and Moccasin

(all pit vipers), the important poisonous snakes found in the nearctic region of North America, comprising Central Mexico, United States and Canada. Persons bitten by Coral Snakes found in the Southern States of our country and in Mexico would have to resort to other treatment. The so-called "Antivenin" (Nearctic Crotalidæ) or North American Anti-Snake-Bite Serum will not neutralize the venom of Coral Snakes. In other countries, antivenin specific for the venoms of the poisonous snakes in these localities must be employed.

If the snake is poisonous, there is also the possibility that the venom did not penetrate the circulation, or as in some instances there is the possibility that the poison glands are not functioning and venom cannot be secreted. In most cases, the presence of venom causes almost instant pain, swelling, discoloration, etc., and the chances are that if these symptoms are absent, the individual was bitten by a non-poisonous snake. As a precautionary measure where the biting occurred in this country in areas where pit vipers prevail, one can take an injection of North American Anti-Snake-Bite Serum. This will not cause any outward effects, even though venoms from pit vipers are not present in the system of the individual into whom the antivenin is injected.

Every naturalist, botanist, prospector, hunter, and sportsman, tourist, perpetual hiker and camper, surveyors, civil engineers and workers for public utility companies and those engaged in forestry and construction operations venturing into regions known to contain venomous pit vipers should carry along with them first-aid treatment for bites by these poisonous snakes. The drug store or if there are no drug stores in small communities, then the general store and all camps in localities where these snakes abound should have at all times first-aid kits. In the latter the following articles should be found: Two packages of North American Anti-Snake-Bite Serum (or the specific antivenin if in other countries), containing sterile syringe and sterile needle; several stout rubber bands or a rubber ligature; a sharp knife, scalpel or razor, a few sterile bandages and a package of sterile gauze; a small breast pump or other suction device, and tincture of iodine or other antiseptic. Dr. Dudley Jackson and Colonel Crimmins, in their campaign against poison snakes in Texas, have been using effectively the Dudley Kit which contains small rubber bulks, a unique suction type of apparatus. A first-aid outfit should be kept in a place where it can be obtained quickly, as promptness is essential in the beginning of the treatment.

(2) *Place a ligature or tourniquet,* preferably a rubber band, *above the bite (between the bite and the heart).* Don't lose time, but apply this promptly as soon as bitten, even if a strip of cloth torn from a garment has to be used instead of a rubber band, etc. By twisting a stick into the rubber band or ligature, the latter will be made tighter. The ligature should be released for a few seconds at five to ten-minute intervals to maintain necessary circulation and to prevent gangrene from setting in. This will prevent, or at least delay to a great extent, the systemic absorption of a deadly dose of venom from the amount present in the tissues immediately surrounding the wound. Above all KEEP YOUR HEAD, don't get despondent or excited, but ACT PROMPTLY AND SYSTEMATICALLY.

(3) If you are in reach of medical or scientific aid, call a doctor or a scientist who know how to treat snake-bite wounds. If they cannot be reached, then get the proper serum, and inject it yourself. If you do not have antivenin with you, arrangements should be made AT ONCE to procure some. Telegraph and use the aeroplane if necessary. *The early judicious use of the proper antiserum or antivenin is the best remedy available today in the treatment of snake bites.* If you have to give the injection yourself follow the directions as given on the label or circular. As the injection is about to be given, remove the ligature, or if the antivenin is administered within a few minutes after being bitten, a ligature or tourniquet is not needed, and in fact, should not be used, as it is necessary for the antivenin to circulate freely throughout the blood stream.

(4) Squeeze the wound to make the blood flow freely. This may carry away some of the poison. Incisions into and about the fang punctures so as to enlarge and make them deeper is still used by some, but most workers today claim that there is no particular advantage in doing this. Suction may be applied. It may prove to be of some value. Incision and suction are not necessary if antivenin is used early. In fact, if antivenin is available, incision is to be condemned, as there is a greater possibility of an infection setting in when the skin is cut.

(5) Don't pack the wound with crystals of potassium permanganate, and don't apply poultices or alum or parts of a snake's or other animal's body, or pour on the wound coal-oil or whiskey. Don't take alcohol or ammonia in any form internally.

Keep warm. Local treatment should be used by the Doctor, for it is of the greatest importance, as epsom salt or sodium citrate dress-

ings for inflammation, novocain injections to alleviate pain, etc. Coffee (or caffein) or the use of strychnine should also be avoided as this tends to raise the blood pressure, but there may be used if symptoms of weakness or giddiness develop or if the fangs may have struck an artery so that the venom was injected directly into the blood vessel.

(6) There is always a possibility that a wound made by the bite of a snake may become infected. It is, therefore, advisable to apply an antiseptic or an antiseptic dressing to the wound, even though the individual bitten survives the primary effect of snake poisoning.

The use of alcohol internally is to be condemned, as it is undoubtedly harmful. Alcohol stimulates heart action, thus helping absorption and it lowers the blood pressure which is just what is not desired. In addition to the delay of the absorption of the poison, it is desirable to maintain at all times a high blood pressure. There is many a story told about whiskey having saved the life of a human who was bitten by a snake, and in practically all of these so-called "cures" by alcohol the biting was performed by a harmless snake.

THE VENOM OR THE POISON

Poisons are produced by various venomous animals. Frogs and other Amphibians secrete a poison, which though not fatal to humans except in very large doses, nevertheless possesses irritating properties. Most Amphibians as frogs, toads, etc., derive their protection by pouring out this poison on the skin. Certain fish and other creatures are fitted with projecting bones or spiny fin-rays with which to introduce their poison. Various spiders and scorpions are capable of causing considerable trouble by their stings or bites due to the poison which is injected. In fact, in some tropical and semi-tropical areas, the latter are a real menace and attempts are under way to prepare specific antivenins to combat scorpionism (scorpion poison) and arachnidism (spider poison). You are all familiar with the fact that the savage races have used at various times the poisonous products from snakes, lizards, fishes, toads, and the juices from ants, bees, beetles, centipedes, spiders and wasps for their poison arrows.

SNAKE VENOM OR SNAKE POISON

Snake venom is a secretion derived from the supralabial gland. The latter is a more or less developed gland present on each side of the head beyond the eye above the lip margin and resembles in its development the parotid salivary gland in mammals. The amount of venom secreted varies with each species and generally speaking is in propor-

tion to the size and age of the snake, the length of the period of hibernation, fasting, repose, etc., and other environmental factors. Larger and older specimens secrete larger amounts of venom. The venom from the different groups of poisonous snakes vary in their toxicity as well as in their therapeutic action. The amount of poison injected (in relation to the size of the animal) and the degree of its virulence (which varies not only in the different kinds of snakes, but in the same snake under different conditions) governs the seriousness of the symptoms or whether death will result. In examining a wound made by a poisonous snake, the distance between the two punctures made by the fangs frequently bears a relationship to the amount of venom injected. If the fang-puncture points are far apart, it is more than likely that a large snake and one capable of throwing forth a large amount of venom caused the bite. And it is well to point out again that as important as is the toxicity of the venom and the amount secreted is the ability of the inoculating apparatus (the fangs) of the snake to inject or introduce the venom into the deeper tissues of the animal bitten.

The venoms or poisons are viscous, yellowish liquids, clear or very slightly clouded; and containing in solution as they do an amount of protein equivalent to from one-quarter to one-third or more of their weight, they are grouped with the proteins. The remaining substances present are water, carbohydrates, small amounts of inorganic salts and occasional admixtures of abraded epithelial cells or other cellular material. Venom may contain different ferments or enzymes and one or more of several toxic elements which vary in their activity and action. Some of the ferments which may be found are: Proteases (proteolytic ferment), which may produce softening of muscle tissue; lipases (lipolytic ferment), which possesses a feeble action in the splitting of lecithin and in the fatty degeneration of the liver; a diastatic ferment, which may activate the inactive pancreatic juice so that the latter will attack albuminoids; and a fibrin ferment, which attacks fibrin, the coagulating element, resulting in a loss or reduction of capacity of the blood for coagulation.

The snake venoms contain one or more of several toxic elements which may attack red blood cells (classified as hemotoxins and hemaglutinins), nerve cells (neurotoxins), white blood cells or leukocytes (leukotoxins) and endothelium (classified as endotheliotoxin, endotheliolysin or hemorrhagin). The hemorrhagin is especially marked in the Rattlesnakes constituting the chief toxic element in the venoms

of these pit vipers. The endothelial lining of the blood vessels, and in particular that of the capillaries, are destroyed and there soon appears hemorrhagic (bloody) infiltration and an enormous swelling around the wound. The venoms that are neurotoxic cause death by paralysis of cardiac and respiratory centers. Neurotoxins are present in but relatively small amounts in the venoms of the pit vipers but predominate, being present in great amounts and are the chief agents causing death in the venoms of the genus Micrurus containing the Coral Snakes as well as in the other Elapine Snakes, including the Cobras and their allies. The only important exception worth while mentioning is in the case of the South American Rattlesnake, which unlike other species of Rattlesnakes contains a strongly neurotoxic poison which has a selective action for the optic nerve, producing blindness almost immediately.

The action of most venoms in human beings is observed by a local reaction almost immediately after being bitten. These symptoms are usually severe and painful. The only important exception is in the case of bites by the Kraits found in the Old World, where in most cases local reactions do not occur. The poison or venom after being introduced into the deeper (subcutaneous) tissues, reaches finally the general circulation by absorption through the lymph and blood vessels. Snake venom is absorbed by the conjunctiva and is not absorbed in the mouth or alimentary canal unless abrasions and cavities in teeth are present. The gastric juice destroys most all venoms except that secreted by the Cobra, the Old World Vipers, and the Black Snake of Australia (Pseudechis porphyriacus).

The rays of the spectrum, as well as rays from radium and electricity, reduce and finally destroy the toxic power of snake venom. Varying degrees of heat, differing somewhat for the venoms from the several groups of poisonous snakes, as well as certain chemicals, will detoxify venom in vitro (that is, in a test tube). When snake venom is dried without heat, small amber-like crystals of material are obtained. Venom thus dried or dessicated retains the original toxic qualities of the liquid in unaltered strength for long periods of time.

IMMUNITY AGAINST SNAKE VENOM

Poisonous snakes are immune against their own venom, so that if poisonous snakes of the same species bite each other and if a snake injures itself as it may at times, any venom which may be injected will have no effect. The "mussarana" in Brazil, known also as the "zumbadora," and the king snake in this country are immune to

the venom of poisonous snakes. The armadillo, peccary, skunk and hedgehog are other important natural enemies which are immune. In the case of the hog, it is questioned whether there exists a natural immunity as it is believed that the venom rarely enters the deeper vascular tissues due to the thickness of the skin. The mongoose, which was made famous as an eater of poisonous snakes, has been said to be immune to the venom of poisonous snakes, but this is an error, as this mammal is not immune.

SPITTING SNAKES

Some snakes are capable of discharging the venom without actually biting. They shoot or direct their poison from their mouths in a fine spray or jet often to a considerable distance. Such snakes are known as "spitting snakes." The venom is not irritating to the skin (unless the latter is abrased or cut), but if it penetrates the eye, at which the snake seems to aim deliberately, there is a rapid absorption, sharp and intense pain, and even a temporary blindness. If treatment is applied immediately, the inflammation of the conjunctiva subsides in a few days. The important spitting snakes are found mainly in Africa, although the Indian Cobras, Russell's Viper and even some species of Rattlesnakes have been known to make use of the ejection of a spray of venom at certain occasions.

The Ringhals (Sepedon hæmachates), a South African Cobra, is quick and vicious and is capable of ejecting fine jets of poison for a distance of 6 to 8 feet, usually aimed with a fair degree of accuracy at the aggressor or observer. One is therefore apt to receive the dangerous poisonous spray in the eyes if these were not protected with glasses or goggles. The latter are generally employed when handling these snakes in captivity.

INTERNAL AND OTHER REMEDIES FOR SNAKE-BITES

Max Neuberger, in his "Geschichte der Medizin," mentions that Greek and Roman writers have handed down a number of fables according to which we owe many therapeutic means and measures to animals, and he states that tortoises were used as an antidote for certain kinds of snake bites. He also mentions that in India the bitter root of Ophiorrhiza mungo was and is used as an antidote for snake bites. Guaco or huaco, known also as herba de Cobra or Yerba capitana, being Mikania guaco, is probably the best known alleged antidote for snake poisoning. This is valueless both in the treatment of snake bites or as a prophylactic. Simaba cedron, another plant, the nuts of

which have been and are used as well as a host of other plants and drugs are also valueless. Snake stones which are calcareous concretions extracted from the bladders of various animals are used in India and other Oriental countries, but they, too, do not possess real curative value. May I repeat again that most all remedies other than mentioned are valueless or even harmful and are to be condemned. The most reliable treatment is an injection as soon as possible of an adequate amount of ANTIVENIN which had been prepared from the venom of the same species of snake, which did the biting. In this country, North American Anti-Snake-Bite Serum will answer in all cases except when bitten by Coral Snakes. Then don't forget the immediate application of a tourniquet until the injection is given and the other measures mentioned may follow.

ANTIVENIN You have observed when considering snake venom that certain agents will detoxify the latter when both are mixed together in a test tube or in any other container. But such agents cannot be employed in our bodies during life (in vivo) as the venom is so quickly absorbed that it would be beyond reach of these chemicals. In other instances, the latter cannot be used as they would exert an injurious effect upon our tissues and body cells. Aspiration, or suction, though practical, and this should be used when possible, does not always yield effective results as the undesirable element in the venom fixes itself frequently to certain tissue cells and cannot be extracted by these mechanical agents and methods. Attempts have, therefore, been made to find some remedy which could be injected into the body and which would neutralize the toxic elements of the venom before the latter would be fixed to tissue cells and destroy the latter and finally cause death. This resulted in the production of Antivenin.

In the case of an injury with a rusty nail or other implement suspected of containing the organism causing tetanus or lockjaw, we advise an immediate injection of Tetanus Antitoxin. The latter will neutralize any toxin or poison produced or secreted by the tetanus organism before this toxin combines with the nerve cells. In like manner in the case of a snake bite, the average human being does not usually know whether the snake which did the biting was poisonous, or if poisonous, whether any venom penetrated the deeper layers of the skin, or if venom was deposited, whether a lethal (poisonous) dose of venom did penetrate. Generally speaking, we may say as

mentioned, that the appearance immediately of local symptoms and pain are indicative of the presence of venom. But if these do not appear, and one is not sure that the attack was by a non-poisonous snake, then in addition to any non-specific measures as application of tourniquet, suction, etc., specific antivenin should be administered as quickly as possible so as to neutralize any and all of the absorbed venom.

The introduction of antivenin, a serum preparation to combat venom, by scientists, resulted in another great boon for mankind and a decided forward step in the fight of man against the bites by poisonous snakes. The preparation and practical use of antivenin prepared especially for the India Cobras, etc., was attempted about thirty-five years ago by Dr. Albert Calmette of the Pasteur Institute in France. It was soon found that the serum or antivenin was specific only for the neutralization of the venom which was employed for its production. Nevertheless, in spite of this, the specific antivenin was employed in bites by any kind of snakes, with favorable results of course prevailing only there where the specific venom was present. In the Western Hemisphere experimental lots of antivenin were prepared and used by the Rockefeller Foundation and Dr. R. L. Ditmars in this country. In 1899, the Seropathic Institute of Butantan was established by the Brazilian government. Some twenty-seven years later, the Antivenin Institute of America was formed and workers here under Dr. Amaral began to experiment with the venoms of North American Snakes. Twenty-three months ago a license was issued by the U. S. Government authorizing the sale and manufacture of antivenin in this country.

The tendency has always been to prepare an antivenin specific for venoms of all poisonous serpents found the world over, but it has been found impossible or impractical to prepare such an antiserum or antivenin. An antiserum or antivenin specific for all poisonous reptiles in a given locality is possible and is available today. The antivenin prepared by the Seropathic Institute at Butantan will counteract the effects of all poisonous snakes in Brazil. The North American Anti-Snake-Bite Serum or Antivenin (Nearctic Crotalidæ) is effective against the venoms of the principal poisonous serpents of the Crotalidæ. This includes the Rattlesnakes, Copperhead and Moccasin, the important poisonous snakes found in the nearctic region of North America, which includes Central and Northern Mexico, United States and Canada.

In other countries, as in India, there are available Colubrine Antivenin and Viperine Antivenin, wherein the former will be of value for the treatment of all Colubrine venoms and the latter will be specific for all Viperine venoms. The early judicious use of these specific antisera or antivenins is the best remedy available to-day in the treatment of snake bites.

PREPARATION OF ANTIVENIN

The process of making Anti-Snake-Bite Serum or Antivenin is in general in the same way as is the making of diphtheria or tetanus antitoxin. In the case of the latter, the soluble toxin or poison from the diphtheria or tetanus bacillus is obtained while when making the antivenin the venom or soluble poison from the poisonous snakes is employed as the starting point. Injections of these poisons into animals (usually horses) incite the latter to produce antibodies or protective substances specific for the toxin or venom injected and (the serum from such animals are known as an Antitoxin or an Antivenin, respectively).

The initial step, therefore, in the production of antivenin is to obtain the desired venom. Live poisonous snakes must be available to supply the latter. In many instances, the venom is removed from the live snakes kept in the several zoological parks throughout the country. Wherever possible live poisonous snakes are kept at the immunization laboratory. In countries where zoological parks are not numerous or only few of a given variety of poisonous snakes are in captivity, or they are difficult to keep in captivity, arrangements are made to collect as many of the different varieties and keep them under more ideal natural conditions so that their young may be collected, and also under these conditions better arrangements may be available for the study of the habits and other characteristics of poisonous snakes. Such a snake farm is known as a serpentarium. A large serpentarium operated by the Seropathic Institute of Butantan is to be found in Brazil where the snakes live in stone houses resembling Eskimo igloos. Fences and narrow moats filled with water prevent the snakes from escaping. In the serpentarium near Tela, Honduras, operated under the joint cooperation of the United Fruit Co., the Harvard Museum of Comparative Zoology and the Antivenin Institute of America, many small celotex huts are available under roofs of manaca palm trees. Here are to be found the different varieties of poisonous snakes commonly found in these countries. The construction of snake farms or serpentariums where snakes are

bred is perhaps cheaper than could be possible by resorting to methods of obtaining the specific species in the wilds or in their respective habitats. For use in commerce, serpentariums have not as yet been developed. This is impractical or unwarranted or too expensive when compared with the present procedure of obtaining the skins. Then again not knowing how long the snake hide fad will last, it is perhaps inadvisable to resort to breeding, when in the jungle and forest regions of Asia and Africa they are so numerous and labor for obtaining them is comparatively so cheap.

Arrangements are then made to remove the venoms from these poisonous snakes at designated intervals, usually every two or three weeks. The snake is caught, snared or lassooed either by the use of a forked stick, a noose or hook stick, and its head is pressed down to the ground. It is then grasped behind the head and around the neck with the operator's left hand, the reptile's body being held under the arm, or if it is a large snake between the thighs and some other support, or the tail is held by an assistant. Various techniques are then employed for obtaining or extracting the venom. In this process of extraction the snake is made to imitate its natural "strike." This is accomplished by forcing its fangs against a shallow glass cup, or by means of forceps the snake's mouth is opened and the reptile is induced to bite through a diaphragm of parchment or rubber sheeting stretched over a glass cup. The glands around the sides of the head are then massaged gently to force out all of the venom. This process is at times spoken of as milking. The fluid which is expelled in the receptacle in an amount of from 2 to 30 drops, averaging 10 drops from each snake, the quantity varying depending upon the size and other characteristics of each snake, appears as a thin viscous fluid about the consistency but more yellowish than the white of an egg. If any blood cells or other cellular matter is present these are removed by whirling the venom about in a centrifuge. The cellular matter deposits and the absolutely pure venom is thus obtained by drawing off the clear supernatant liquid. This may be mixed with an equal quantity of glycerin and kept in the ice box or shipped, but a still better method is to directly dry the material. The venoms from the same species of snakes can of course be mixed together. In drying, the venom is placed in shallow dishes, properly covered, and these dishes are placed in an incubator at body temperature for at least 48 hours. Small amber-like, brittle scales are the result and these may be kept indefinitely and shipped far and wide. This venom in its natural state, unaltered but dried, is employed as the

starting point in the making of antivenin. The first step of the collection of the venom and its drying does not necessarily have to be conducted at the immunization laboratory. Venom can be collected and dried in any part of the world and shipped to the laboratory where the horses are to be immunized for the production of the antivenin.

The next step is to proceed with the process of immunizing the horses. The dried venom is redissolved and an extremely small amount is injected into the horses as the first dose. The dosage is very gradually increased at each subsequent injection that is given, generally from every three to five days. The dosage of venom may be accurately graduated, for it is possible by various technical operations to determine the strength and thus standardize the venom.

At various intervals during the process of immunization, trial bleedings are made to determine the progress in the development of antivenin, the latter being antibodies specific for venom. When the peak of antivenin content is reached, additional injections of venom will not increase the antivenin content. It is, therefore, necessary to make these trial bleedings to find out when the peak has been reached, for it is then that the horse is ready to be bled. This period of immunization may take six months or more. The last dose of venom is an amount almost 1000 times as large as the initial one and still the horse is able to tolerate it, due to the large amount of venom antibodies or antivenin present in its blood.

When the horse is ready to be bled, from one to three gallons of blood are withdrawn from the jugular vein. The serum is separated from the corpuscles and other elements and by a series of technical processes as is practised in making diphtheria antitoxin, the antivenin is purified and concentrated. This reduces the bulk of the finished antivenin and rids it of almost all of the valueless, and in fact, harmful horse-serum protein. After a fairly dependable method of standardization and the performing of several tests to insure that the marketable preparation is sterile, the antivenin is placed in suitable containers or syringes ready for its life-saving work.

Antivenin is best preserved at ice box temperature, but even at a moderate temperature it will keep its strength for many years. Antivenin manufactured in this country is effective against the bites of the Copperhead, Moccasin and Rattlesnakes. It is supplied in syringes containing approximately one-third of a fluid ounce of material. If medical aid is available, the injection is given directly into the muscles (intramuscularly) or into the veins (intravenously),

CASES OF SNAKE BITES REPORTED DURING 1928 IN UNITED STATES

(As Reported to the Antivenin Institute of America)

													Total
North Atlantic and Central States:													
Vermont				1									1
Connecticut				3									3
New York	5		1									1	7
Pennsylvania	26			7								8	41
New Jersey	3											4	7
Delaware	1												1
Maryland	7											1	8
Ohio	9			1									10
Michigan		2a	1	2								1	6
Illinois	2	1											3
Minnesota					1							1b	2
Iowa					1								1
Wisconsin												1	1
Southeastern and Gulf States:													
Virginia	17			3								4	24
West Virginia	14											1	15
Kentucky	2										1c		3
North Carolina	9	1		7							4	2	23
South Carolina	5			4			1				1		11
Georgia	3	4		3		1	2				9	9	31
Florida		7		7		1	8				2	3	28
Alabama	11	12		1		4					16	3	47
Mississippi	1	3		2		3	1					7d	17
Missouri	6	1										1c	8
Arkansas	5	1		3		1					4	3	17
Louisiana		6									3	5d	14
Tennessee	4			2		1						1	8

	Copperhead	Cotton-Mouth Moccasin	Massasauga	Crotalus horridus	C. confluentus	Ground or Pigmy Rattler	C. adamanteus	C. oreganus	C. cerastes	C. atrox	Rattler Species	Undetermined Species	
Western and Southwestern States:													
Montana					7								7
North Dakota												1b	1
South Dakota					5								5
Wyoming					3							1	4
Nebraska					5								5
Colorado					10								10
Kansas	1				5						1		7
Oklahoma	3									2			5
Texas	33	5		2	1	1				89	14	16	161
New Mexico					1					4	7	2	14
Pacific Coast and Rocky Mountain States:													
Arizona									3	1	7		11
California								24		1	5		30
Oregon								1					1
Washington								1					1
Nevada								1	1				2

A—in capitivity.
B—C. atrox in captivity.
C—in carnival collection, probably C. atrox.
D—one Coral Snake.
E—non-poisonous.
F—with circus, probably C. atrox.

so as to hasten the introduction of the venom antibodies. If a physician is not available, then antivenin can be administered by anyone familiar with its use, or it can be self-administered if necessary in the same manner as a patient having diabetes injects insulin beneath the layers of the skin (subcutaneously). Children require larger amounts of antivenin than would be the case in an adult bitten by the same poisonous snake. Where considerable time has elapsed before the injection of the antivenin, or if there is reason to believe that a large amount of venom was deposited when bitten, more than one syringe of the antivenin should be injected. At all times, if there is no improvement within four to five hours after an injection, a second dose of antivenin should be administered and a third or even fourth dose may be indicated if at six-hour intervals no improvement is apparent.

If a tourniquet had been applied, it should be removed immediately as soon as the antivenin is injected; or if when bitten antivenin is at hand to be injected immediately, then a tourniquet should not be applied. The miraculous effect obtained by the use of antivenin, not only in the fact that there is a swift recovery, but especially that there is a clear recovery without any local symptoms or discolorations, is only appreciated by those familiar with the after-effects of a snake-bite poisoning. Antivenin has accomplished and is accomplishing in snake-bite poisoning what diphtheria antitoxin has accomplished in the treatment of diphtheria.

LAWS ENACTED FOR PROTECTION AGAINST OPHIDISM

It is interesting to note that thirty-four months ago the Costa Rican Congress passed a law which forbids the sales of remedies against snake bites unless they are specifics to be employed in scientific methods of treatment of snake bites. They also require the health authorities to publish data relating to Ophidism and its treatment and a supply of specific Antivenin and first-aid outfits are to be kept in all public dispensaries, railroad stations, and in Government or other public buildings, so as to be easily accessible. This law is indeed a forward step along the proper lines and a similar enactment should be passed by the governments of other countries which have to contend with poisonous snakes, and especially where bites by the latter may interfere with the health of their people or even appear as an economic factor.

SUMMARY OF ALL REPORTED CASES IN U. S. A. DURING 1928

	No. of Cases	Death	Death Rate
Antivenin	427	13	3.3%
No Antivenin	174	17	10.2%
Total	601	30	

In the first table, you will observe the distribution of the poisonous snakes in this country. In the second table, you will observe the high death-rate in snake-bite poisoning, where Antivenin was not used. The 3.3 per cent. death-rate where Antivenin was used would have been markedly reduced, if in those cases the Antivenin was used immediately or at least as soon as possible after being bitten, and in few instances if a larger amount of the Antivenin was used, necessitating two or more injections. These two tables, as well as the illustrations, were obtained through the kind courtesy of the Antivenin Institute of America.

HEART BEAT AND BLOOD FLOW

By Horatio C. Wood, Jr., M. D.

THAT UNFORTUNATE and foolish monarch, Charles I, who lost his head so completely and literally, did one thing for which humanity should ever be grateful. He made John Harvey his private physician. This royal favor emboldened Harvey to publish his revolutionary theory of the circulation of the blood, and at the same time gave him the prestige to force his skeptical contemporaries to listen to him. Harvey's discovery may well be said to be the birth of modern medicine; from it springs not only our present understanding of diseases of the circulatory apparatus, but, also, on it has been built a large part of our knowledge of physiology. In the 300 years since Harvey's theorem we have added to it certain refinements, but the fundamental principle which he propounded has undergone practically no alteration.

Horatio C. Wood, Jr., M. D.

The word "circulation" is derived from the Latin "circulo"—to form a circle—and the basic and novel idea for which Harvey is responsible is that the heart and blood vessels form a complete circle, or rather a double circle, through which the blood runs continuously in one direction. Before his time the flow of blood had been conceived as a to-and-fro motion, like the ebb and flow of the tides. The two circles are so intertwined that neither of them is complete without the other. The smaller circle is through the lungs and is connected with the larger circle which goes through the rest of the body.

The pump which drives the blood around these circles is called the heart. It is divided into two parts: a smaller one, lying towards the right side of the body, which pumps the blood through the lungs, and a larger one, lying to the left, which forces the blood through the rest of the body. The blood which is pumped by the right side of the heart passes through the lungs and empties into the left heart, and by this is pumped through the rest of the body, eventually reaching the right side to again start on its course around the body. Each side of

the heart is divided into two cavities: a vestibule for the reception of the blood flowing into the heart, known as the auricle, and the real pump, which is called the ventricle.

The heart is a hollow muscular organ, when contracted about the size of the fist, lying in the upper part of the chest, nearly in the middle. The pulsation that can be felt in the neighborhood of the left nipple represents the extreme left-hand border of the heart. Around the heart is a membrane, called the pericardium, which forms a sort

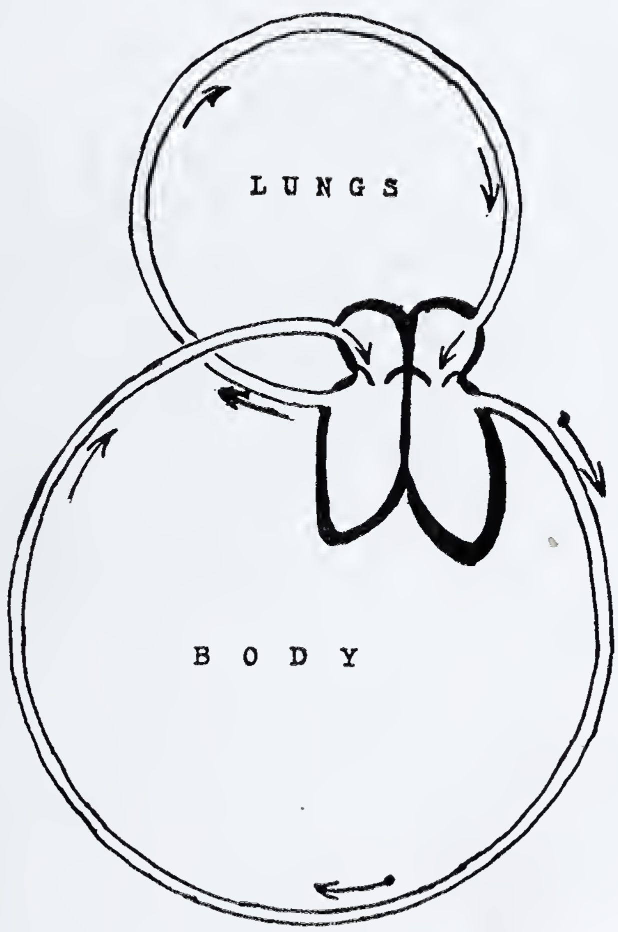
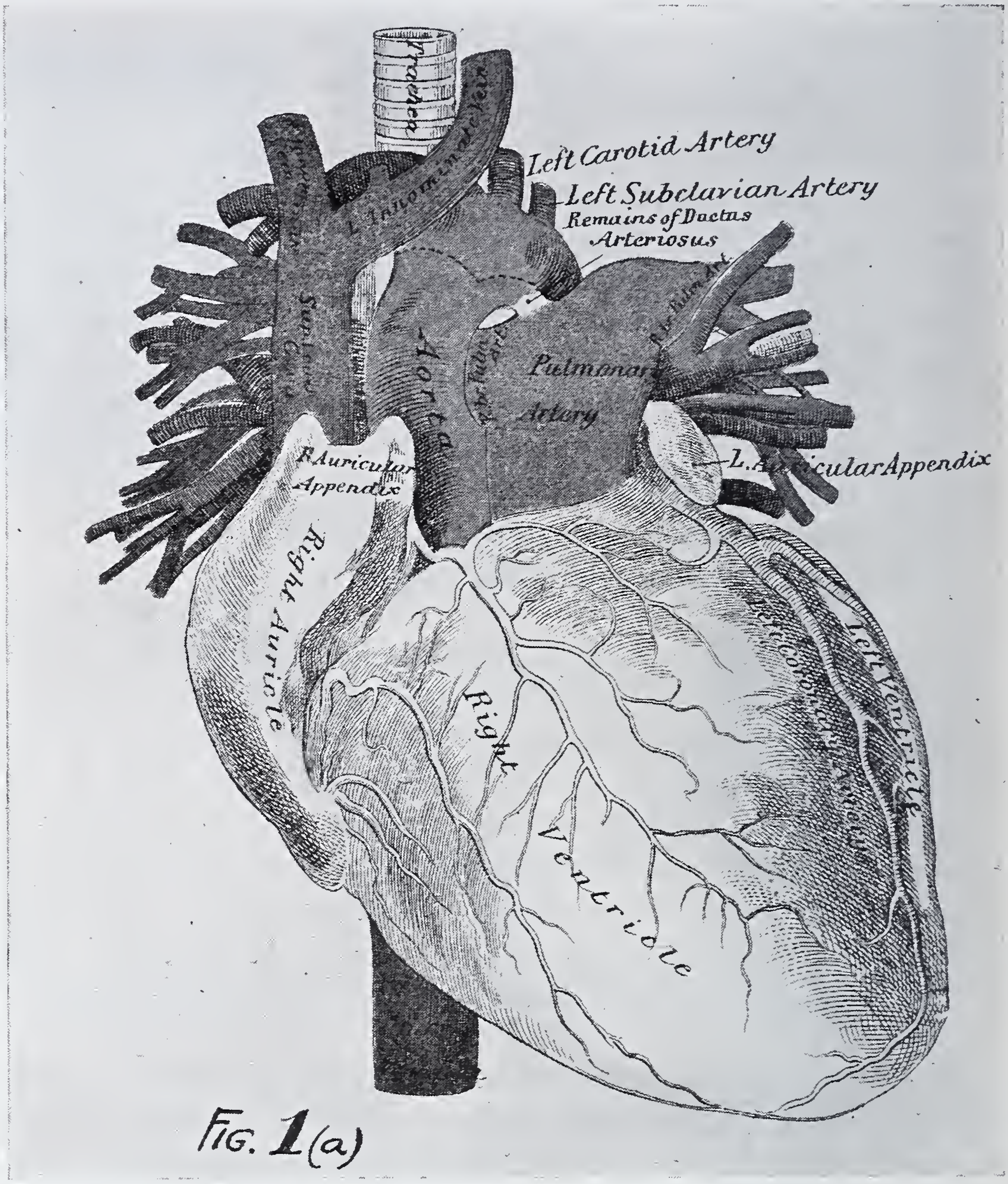


fig. 1

Diagrammatic scheme of the two circles of blood flow through the lungs and the rest of the body, with the heart in the center forming the connection between them.

of sac. This membrane tends to lessen the rubbing or friction of the heart against the lungs, which almost entirely surround it. The amount of work that this little mass of muscle performs is simply stupendous. Every minute each ventricle pumps about seven quarts of blood. In an hour, therefore, the heart would pump nearly seven barrels of blood, while the quantity pumped in one week would fill a cylindrical tank 10 feet in diameter and 22 feet high. This enormous amount of work is accomplished by a mass of flesh weighing less than twelve ounces.

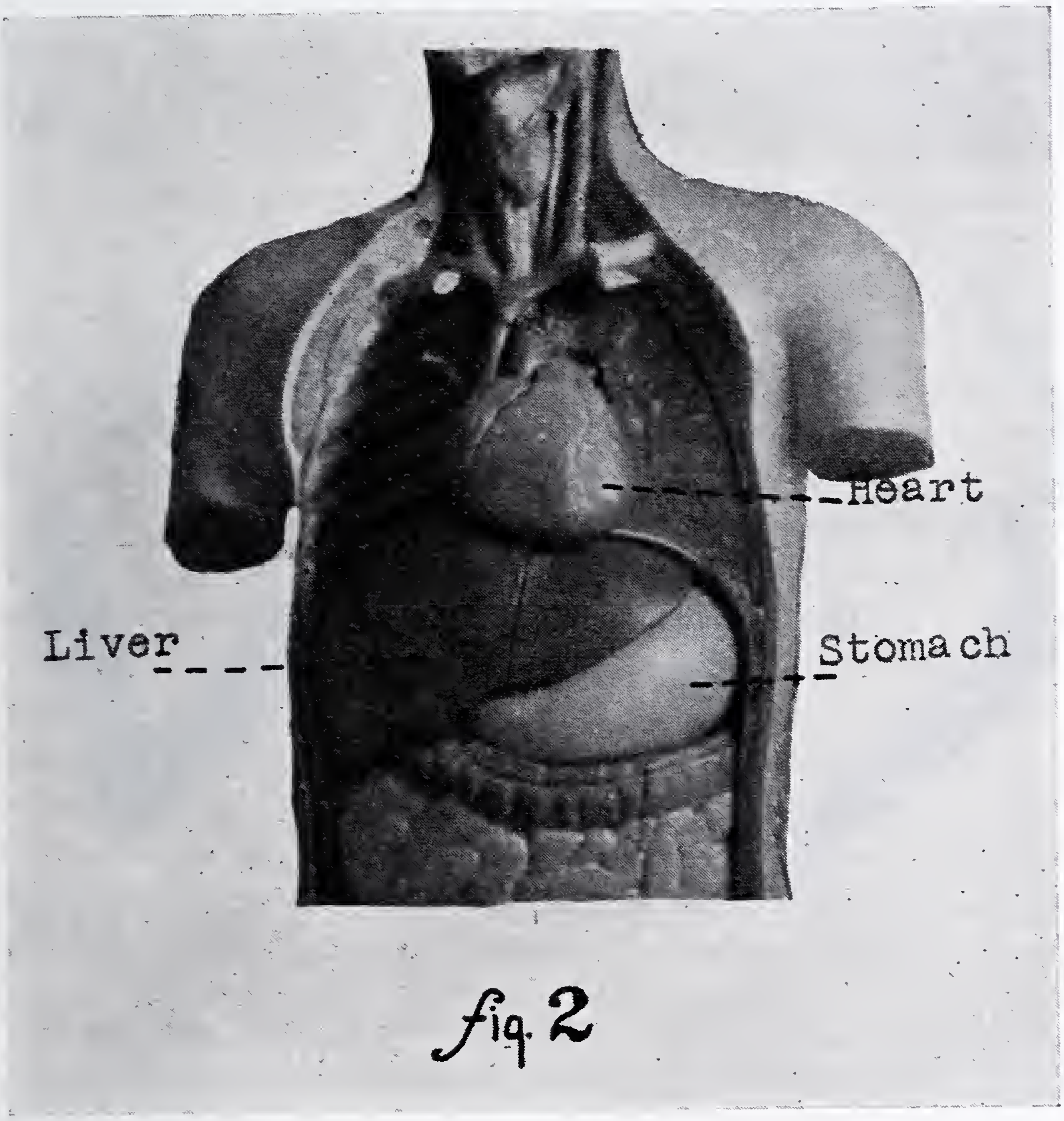
What makes the heart beat? Other muscles of the body contract only when an exciting stimulus affects them, and then they respond to each stimulation with a single contraction. But the heart muscle goes on contracting continuously at regular intervals without any apparent cause. Remove the heart of a frog from the body entirely, lay it on a



Showing heart and great vessels. (After Allen.)

plate, and it will continue to beat for hours. The heart of a warm-blooded animal will also beat under similar conditions although not for so long a time. By furnishing it with proper blood, however, even the heart of a man has been kept beating for twenty-four hours entirely outside of the body.

At one time physiologists were inclined to attribute this continuing activity of the heart muscle to certain nerve cells which are found in the heart, but today it is generally regarded as an inherent property of the muscle itself. It is believed that the cardiac muscle, which differs in structure from all other muscle tissue, has within itself the power of contracting spontaneously at rhythmical intervals. Not all parts of the heart possess this property in equal degree; if the



Showing the location of the heart in reference to other internal organs. (After His.)

ventricles be separated from the rest of the heart they may continue rhythmically contracting but at a much slower rate than normal. The most actively beating portion is just at the junction of the great veins with the auricle. The contraction wave which starts here spreads through the rest of the heart, making the ventricles beat more rapidly than they would by themselves. This area is therefore often called the "pacemaker" of the heart.

The real work of the heart, as I have said, is performed by the ventricles, and the opening into each ventricle is guarded by valves so arranged that the blood can only flow in one direction. These valves are formed of folds of the lining membrane of the heart, which is called the endocardium. In certain infections of this lining membrane, which we call endocarditis, the valves may become distorted so that they cannot function properly. The result of this is similar to that produced by a leaky valve in an automobile, namely, a reduction in the efficiency of the engine. This can be, to a certain extent, compensated for by greater activity of the muscle of the heart. If there is not too great a strain thrown upon such a heart, even despite the dis-

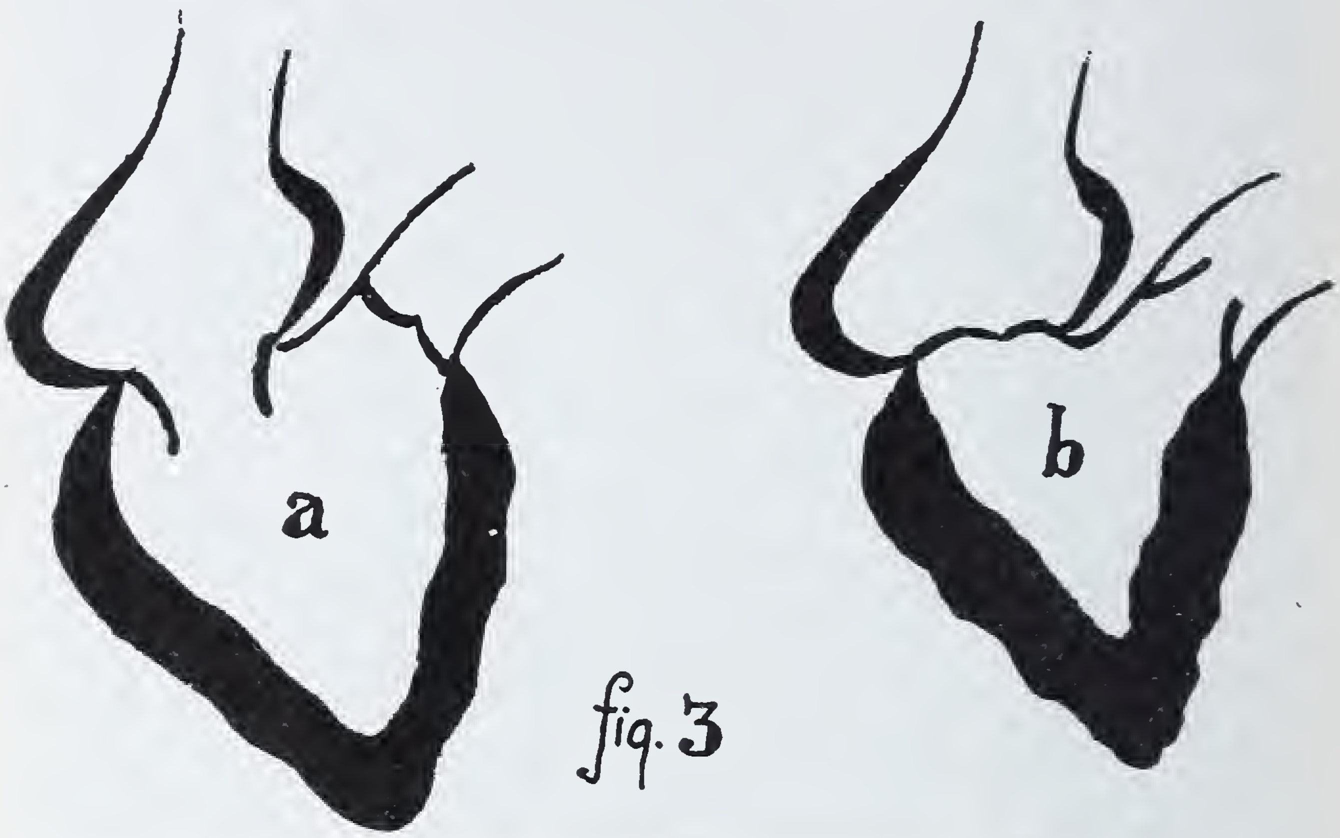


Diagram to show action of valves of the heart. a = heart in diastole; b = heart in systole.

advantage of a leaky valve, it may continue to fulfill satisfactorily its functions for an indefinite period of time. It is important, however, to remember that even although apparently doing its work adequately, it is nevertheless distinctly reduced in its mechanical efficiency and is likely to be overtaxed by sudden increases in demand made upon it, as by violent exercise. For this reason persons who suffer with valvular heart diseases, while they need not worry about shortening their span of life, should always be careful about over-exerting themselves.

The pipes or tubes through which the heart pumps the blood are of three kinds: the arteries through which the blood leaves the heart, the veins which carry the blood back to the heart, and the capillaries,

which are very minute blood vessels between the arteries and the veins. These capillaries, although extremely small—averaging about one-two thousandth of an inch in diameter—form a complex network all over the body, which will hold more fluid than all the large arteries and veins combined.

It takes force to drive a fluid through such a series of tubes, and when the driving force meets the resistance which is caused by the friction against the walls of the vessels in which it is enclosed, there develops what is known as pressure. If the fluid in such an arrangement of tubes is water, we would call it hydraulic pressure, but when it is blood we call it blood pressure. Ordinarily when we speak of blood pressure we mean the pressure in the arteries; in the capillaries there is relatively little pressure and in the veins scarcely any at all. The degree of pressure may be expressed in various ways. Sometimes we express it in terms of force exerted against a given area of surface; we say, for example, that the atmospheric pressure is fifteen pounds to the square inch. More commonly and more conveniently we measure pressure in terms of the height of a column of fluid which it will maintain. The height of this column will depend not only on the degree of pressure but also on the weight of the liquid. For the higher degrees of pressure, as represented in the circulation, it is convenient to use mercury, the heaviest known liquid. The principle is that of a mercury barometer. The atmospheric pressure of fifteen pounds to the square inch will hold up a column of mercury thirty inches high, or, if we express it in the metric system, 760 millimeters. The pressure in the arteries varies considerably, not only with the health and occupation of the individual, but changes from second to second with every beat of the heart. Normally it fluctuates from beat to beat between 70 and 120 millimeters of mercury.

The period of contraction of the cardiac muscle which forces the blood onward we call systole, and the period of relaxation of the heart, during which it is being filled with blood, we call diastole. Naturally the pressure in the arteries will be highest immediately after the contraction of the heart; this we call the systolic pressure. The lowest pressure, which occurs during the period of relaxation, we call the diastolic pressure. In a healthy young adult the systolic pressure will usually range between 110 and 130 millimeters of mercury, while the diastolic pressure will be between 65 and 80. When the physician talks to his patient about the height of the blood pressure he usually gives the figures for the systolic pressure. It is the difference between

the systolic and diastolic pressures which causes the throbbing that can be felt in various parts of the body, notably the wrist, the side of the neck and in the temples, which we call the pulse. This difference in the degree of pressure is called the pulse pressure.

One of the most interesting facts about the blood pressure is that although the heart is completely at rest, not pumping at all, for periods of half a second or more, there always remains in the arteries a certain degree of pressure. This is due to the fact that the arteries are not rigid but are elastic, contractile, tubes. When they are over-filled by the systole of the heart they stretch to accommodate themselves to the larger volume of blood, and then during the period of diastole gradually contract, forcing the blood onward into the capillaries. We have an analogous situation in the case of a fire engine. Here is a rhythmically acting pump, but the stream which issues from the nozzle of the hose is a steady, not an intermittent one. This is accomplished by having the engine pump the water into an enclosed space against a cushion of air which maintains the pressure in the hose between the strokes of the pump.

If we remember that the basis of the pressure in the arteries is the friction of the fluid passing through the arteries, it is obvious that the degree of pressure will depend not only upon the pumping force of the heart but also upon the resistance which the arteries offer and upon the fluidity of the blood itself. Very evidently it would require more force to pump molasses than it would to pump alcohol.

The amount of force exerted by the heart may be altered by changing either the number of contractions per minute or the size of each contraction. Some of the older members of my audience may have had the pleasure in their boyhood days of working on a farm before the advent of the electrical pump. You know that on a frosty morning, when you were in a hurry to fill the water trough for the horses, you could do so more quickly either by making rapid strokes or by swinging the pump handle through its largest possible arc. So the heart can increase the amount of blood it pumps either by beating at a more rapid rate or by contracting to the fullest possible degree at each beat.

The resistance offered by the arteries varies with the smoothness of their interior lining, also with their caliber (that is, their internal diameter), and also, to some extent, with the ease with which they stretch. Take the nozzle off the end of a hose and the pressure immediately diminishes, as can be gauged by the force of the stream. The

reason that the pressure diminishes in the hose is because the relatively large caliber of the hose offers little resistance to the passage of the water. If the arteries dilate suddenly, the blood pressure may fall to a dangerously low level. That is the reason that the so-called "solar plexus blow" in the abdomen will sometimes knock a person unconscious; the solar plexus contains the nerves which regulate the caliber of the arteries in a very large part of the body, and injury to these nerves causes a sudden dilatation of these vessels. Indeed, a man will die more quickly from injuries to the nervous system regulating his blood vessels than he will from being stabbed in the heart.

High blood pressure is at present a very prevalent condition. It is not, properly speaking, a disease, but it is a symptom which may occur in a large variety of diseases. It is well known that the blood pressure of persons in advanced years is usually higher than in the days of their youth, even in healthy persons. This rise, which may be called the natural rise in blood pressure, is due to the fact that our arteries, like our other organs, become less elastic as we grow older. Sometimes the interior lining of the arteries becomes roughened and thereby makes more friction, which in turn causes an elevation of blood pressure. At other times increased blood pressure may be due to constriction of the arteries caused by purely nervous factors; a sharp temporary rise in blood pressure will occur in almost any one upon being suddenly startled. Certain poisons, which may arise within the body or which may be introduced from without, can excite the blood vessels to undue contraction and thereby cause high pressure.

In some persons a blood pressure higher than that of the average seems to be natural and people are not infrequently made uncomfortable by injudicious lowering of the blood pressure below that which is normal for them.

The chief danger which comes from high blood pressure is due to the increased strain which is thrown upon the heart trying to drive the blood forward against unusual resistance. The dangers of bursting a blood vessel, which alarms so many people, is rather a remote one. Blood vessels rarely burst if they are healthy, except as the result of direct violence. I have seen persons with systolic pressures more than twice as high as that which we consider normal apparently unconscious that anything was the matter with them.

Apoplexy, or, as it is commonly called, a stroke, is due to the bursting of a blood vessel in the brain, which will be followed by cerebral hemorrhage, and leads to paralysis of greater or lesser extent,

according to the size of the artery which has broken. The blood vessel bursts because of some disease which has weakened its walls. If the blood pressure remains so low that no strain is thrown upon this weakened artery, the patient may go along for years unconscious of any trouble, but some excitement causing a sudden rise in the blood pressure may lead to the rupture of the diseased vessel.

Diseases of the heart are increasing at an alarming rate. In the State of Pennsylvania in the past twenty years the general death rate has fallen from 16 per thousand to less than 12 per thousand, but the death rate from heart disease has gone up 60 per cent. In the statis-

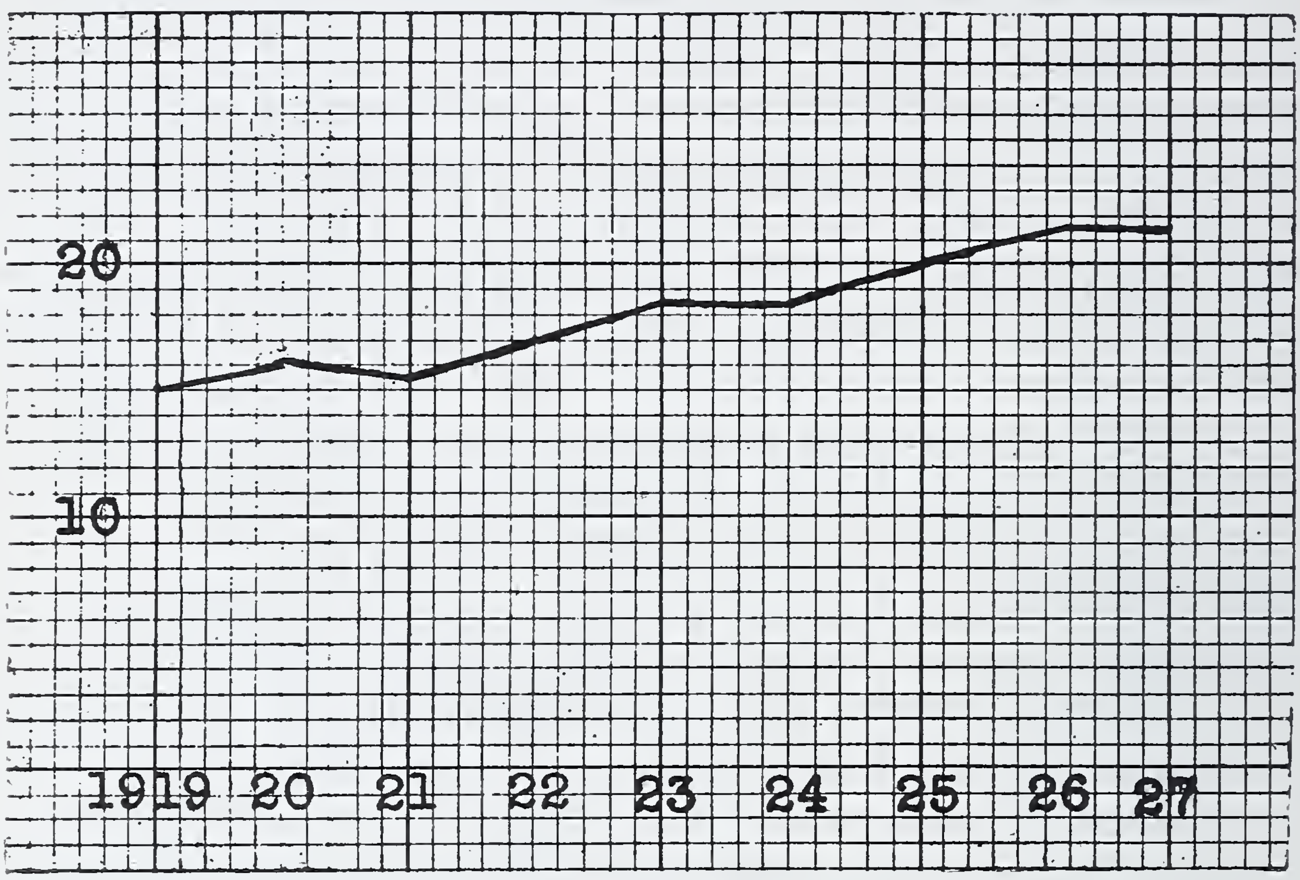


Fig. 4

The rise in death rate from heart disease in Pennsylvania. Figures to the left represent deaths per 10,000 of population; figures below the year.

tics of the Department of Public Health, heart disease has risen from fourth to first place in the causes of death. There is a similar and scarcely less striking increase in the number of deaths of diseases of the arteries.

Diseases of the heart may be divided into two groups: those in which the membranes are primarily affected and those which chiefly affect the muscle. Of the membranes, the interior lining is the more frequently attacked. Inflammations of this membrane are called endocarditis. They may follow a large number of infections in various parts of the body. Among the most frequent causes of endo-

carditis may be mentioned rheumatic fever, tonsilitis, gonorrhea, scarlet fever, septicemia (blood poisoning), etc. As the endocardium covers also the valves of the heart, these inflammations often lead to deformities and leaky valves, which remain as a permanent disability. The disadvantages of leaky valves I have already referred to. Sometimes the muscle after awhile grows enough stronger to carry the extra burden imposed on it, because of the leaky valve, without serious inconvenience. When this happens, the doctors say the heart is "compensated." A person with a compensated valvular lesion may continue to live an almost normal life for an indefinite number of years, but he should always remember that his heart is working at a disadvantage and avoid subjecting it to unnecessary strains, as by violent physical exertion or excessive smoking.

Diseases of the muscle are of such a wide variety of types and of so different degrees of danger that it is almost impossible to give any brief outline. Young persons may recover from them with no apparent remaining ill effect. But in the later years of life as a rule they are a more serious menace than the valvular defects. Muscular lesions of the heart may be caused by any of the infections which give rise to endocarditis, but in addition they may be brought about by various poisons (such as tobacco, headache tablets, alcohol, etc.) or by simply overstraining the heart as in too violent athletics. Frequently they are the result of those changes which, in a minor degree, are occurring in all of us as the years go by, called, popularly, hardening of the arteries.

The amount of disability which results from disease of the heart muscle may range from a scarcely perceptible reduction of normal activity to complete incapacitation.

There is one type of cardiac lesion to which I would like to call especial attention because it is so common a complication of many diseases of the heart and is so frequently the indication of the beginning of the end. This is the condition known to the medical profession as dilatation, which is a stretching of the heart muscle. Whenever the labor that the heart has to perform is beyond its capabilities, becoming unable to empty itself of the blood which continues to flow into it, the muscle begins to stretch to accommodate the abnormal amount of blood which it is unable to evacuate. As the cavity of the heart grows larger, it is obvious that the walls—that is, the muscular tissue—must become thinner, just as when you blow up a toy balloon, the bigger you blow it up the thinner are its walls. As the muscles

become thinner they lose, to a considerable degree their efficiency; they are less able to perform their function. Unless the heart is relieved of its too heavy load it must, therefore, continue to stretch and stretch, its contractions becoming less and less efficient, until finally they cease altogether.

Mild degrees of dilatation are very frequently found in the performers after a severe athletic contest. When the strain is removed, if the athlete be youthful and healthy, the heart rapidly regains its normal tone and within twenty-four hours may be as efficient as ever.

One of the earliest and most certain signs of advancing years is loss of elasticity in our tissues. Elasticity is not the power to stretch, but it is the power to return to the normal condition after having been

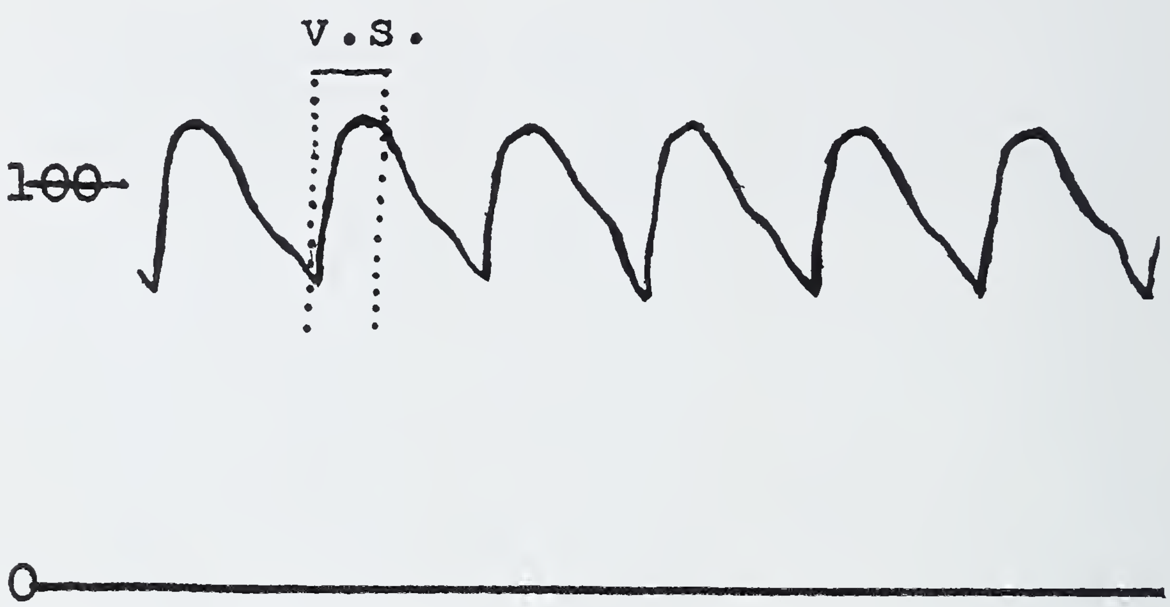


Fig. 5

Showing pulse pressure. V = ventricular diastole; S = ventricular systole.

stretched. Take a rubber band and pull it out and leave go; the band flies back because it is elastic. You stretch out a piece of taffy candy and leave go, and it does not go back because it is inelastic. Take a piece of rubber that has been kept in your desk until it begins to change, and you will find that while it has some elasticity left, when you stretch it it returns much more slowly to its proper size, and if stretched too much will not return at all. So it is with our tissues, especially the heart.

A study of the statistics of the deaths from heart disease shows that the great increase has been in persons above forty years of age. In youth the heart, even when diseased, temporarily overburdened, will recuperate rapidly if relieved of its strain, but in later life a heart once overtaxed returns but slowly, if at all, to its former strength.

As our hair turns gray we must learn, if we wish to live useful lives, that we cannot overstrain, even for a short time, our hearts with impunity.

Every time our muscles contract they require more blood. More blood to the muscles means more work for the heart. Lie quietly in bed and count your pulse and then get up and walk across the room and count your pulse, and you will find that even such a very moderate degree of exercise as walking across the room will reflect itself in increased work of the heart. Climb up a flight of stairs and the

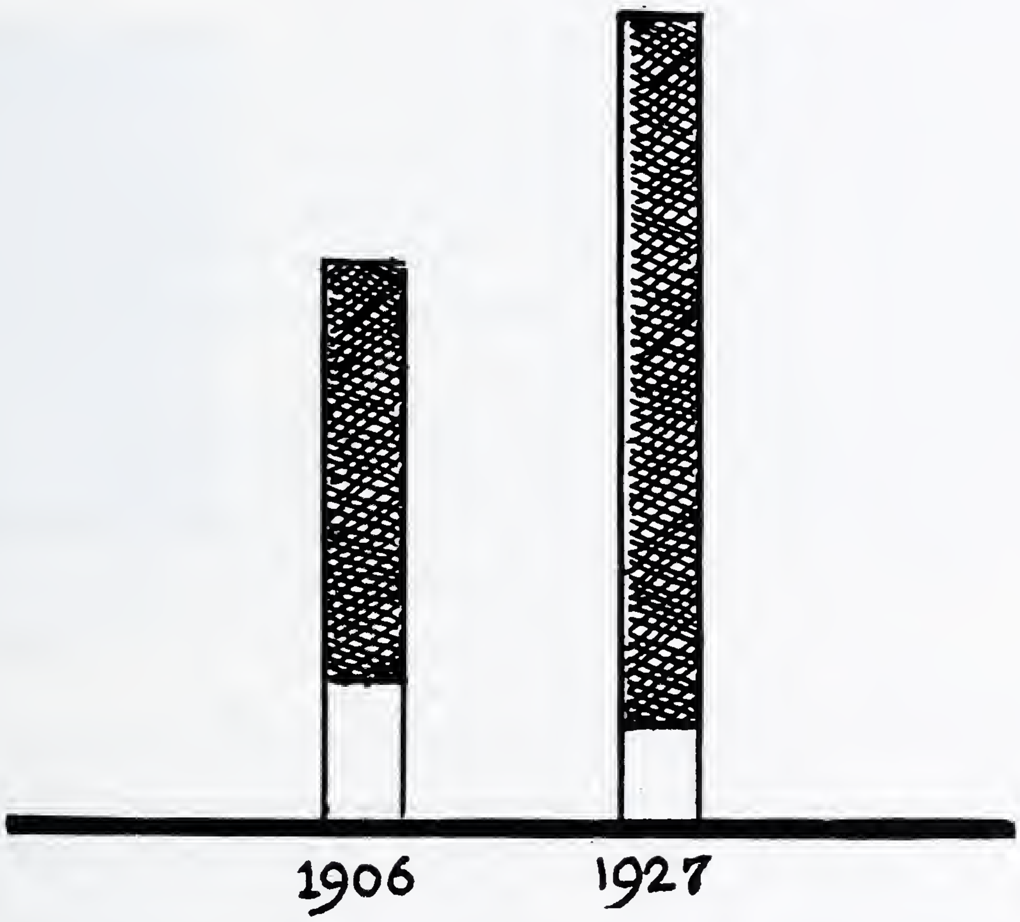


Fig. 6.

Comparative mortality from heart disease in 1906 and 1927. The light area represents deaths under 40 years of age, the dark area over 40.

increase in the pulse rate is very much greater. Run up a flight of stairs and you will be panting for breath and your heart hammering. Generally speaking, the more quickly we move, the greater is the muscular energy expended, and consequently the greater demand upon the heart. The price lesson that patients with heart disease must learn is not to hurry, and I might remind those of you who have reached middle life that every one of you is a potential case of heart disease. Just how much the heart will stand, just how much it is safe for us to hurry or exert ourselves, varies with each individual. But there is

a limit for every one of us, and the prudent man will realize his limitations.

Another source of strain upon the heart is undue constriction of the arteries. I have already pointed out how the contraction of the arteries, by increasing resistance to the flow of blood, tends to elevate the blood pressure. The greater resistance of contracted arteries must be overcome by increased work of the heart. High blood pressure, therefore, means more strain upon this organ. Persons with weak hearts must therefore avoid, as far as possible, raising their blood pressure.

One of the most frequent causes of acute high blood pressure is nervous excitement. Every time we become angry or frightened, rise in blood pressure is well marked, and even pleasurable forms of excitement, such as the thrill which some get from beautiful music, means more work for the heart. The old saying that "good news never killed anyone" is not true; many persons with weak hearts have died of the excitement of pleasure.

Fortunately nature here has arranged a compensatory mechanism for those of advancing years, because as we grow older and our hearts become less elastic, we become less easily excitable. If we miss the pleasant thrills of our youth, we miss also the devastating vehemence of passion. The old man who resurrects youthful emotion is as foolish as he who tries youthful athletic feats.

Lest some should misunderstand me to recommend a life of sloth as the gateway to longevity, let me add that disuse of our functions is as deadly to their efficiency as overuse. If we take no exercise our muscles atrophy, grow weaker. The heart is no exception. It needs the stimulating effect of overcoming obstacles. It often tasks to the utmost the skill of the most experienced physician to determine in any individual case just exactly where lies the border between healthful, beneficial, exercise or excitement and deleterious overexertion. I am not advocating idleness any more than I am recommending violence. Richard Steele, the famous essayist, said, "He that is moderate in his wishes from reason and choice, doubles all the pleasures of his life." I might paraphrase and say that he who is moderate in his exercise and pleasure doubles the days of his life.

THE CARBON OXIDE BROTHERS, MON AND DI

By Freeman P. Stroup, Ph. M.

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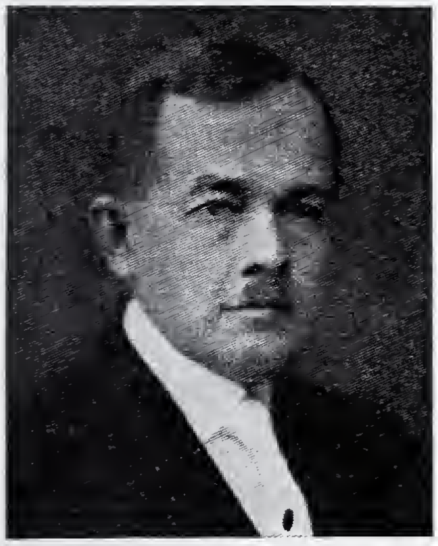
DOUBTLESS some of our auditors this evening have considered the subject of this talk rather far-fetched. To speak of forms of non-living matter as brothers may seem without good reason, but the fact that you are here shows that your interest has been excited, and that is "the why" of our title. It may not be so far-fetched after all when one considers that these two substances are of the same "parentage," so to speak, or compounds of the same elements—carbon and oxygen; are similarly named—carbon *mon*oxide and carbon *di*oxide; are both colorless gases; are as unlike in many particulars as any two brothers you ever knew; are more often found together than separated.



Freeman P. Stroup, Ph. M.

WHY "MON" AND "DI"?

These prefixes are appropriated from the Greek, and mean, respectively, *one* and *two*. The chemist uses abbreviated expressions in place of names for most of the compounds about which he writes, and these he calls "symbolic formulas," "chemical formulas," or, more generally, "formulas." For carbon *mon*oxide he writes CO, and for carbon *di*oxide he writes CO_2; in which C represents one "combining weight," so-called (or 12 parts of carbon), O represents one "combining weight" (16 parts of oxygen), and O_2 represents two "combining weights" (32 parts of oxygen). In carbon *di*oxide there is always twice as much oxygen by weight as there is in carbon *mon*oxide, hence the reason for the differences in nomenclature.

OTHER NAMES

Carbon monoxide is sometimes called "carbonic oxide," and carbon dioxide is sometimes called "carbonic acid," particularly by chemists and others in the autumn period of life. The solution of CO_2 in water (CO is practically insoluble in

water) is acid in reaction and taste, and this acid is the basis of a class of salts known as carbonates; hence the name "carbonic acid" properly belongs to the acidic constituent of such a solution (the chemist writes it H_2CO_3) and the name "carbonic oxide" should then be given to CO_2, the *oxide* which produces the *acid*. "Carbonic acid gas" is another name sometimes used, for obvious reasons. The chemist expresses the reaction which takes place when the gas dissolves in water by what he calls an "equation":

$$\underset{\text{(Carbon Dioxide)}}{CO_2} + \underset{\text{(Water)}}{H_2O} \longrightarrow \underset{\text{(Carbonic Acid)}}{H_2CO_3}$$

At the "soda counter" of the drug store, the candy shop, or the "five-and-ten," this solution is known as "plain soda."

It will be seen that both oxides are known to different people as "carbon oxide," a source of much confusion; hence the reason for modern chemists using the terms "mon" and "di."

"Deadly monoxide gas" and "monoxide" are terms used by newspapers as synonyms for carbon monoxide, particularly in headlines of news articles concerning poisoning by this substance. At this time of the year (winter) these terms catch our eyes more often than in summer, for reasons that will appear later on in this discussion.

NATURAL OCCURRENCES

So far as the speaker knows, there is no occurrence of carbon monoxide in nature, but there are numerous natural sources of the dioxide. A few may be mentioned.

a. Every breathing animal, including the human animal, discharges into the atmosphere with every expiration from the lungs some carbon dioxide. This can be easily demonstrated. If we breathe for a few moments into a glass vessel the inside of which has been moistened with lime water we note a cloudy film on the surface of the glass; or if we bubble the breath for a few moments through lime water we note the separation of a white insoluble substance. Lime water is a saturated solution of calcium hydroxide, and the film on the glass in the first demonstration and the precipitate in the second is calcium carbonate. The following equation expresses what has taken place:

$$\underset{\text{(Calcium Hydroxide)}}{Ca(OH)_2} + \underset{\text{(Carbon Dioxide)}}{CO_2} \longrightarrow \underset{\text{(Calcium Carbonate)}}{CaCO_3} + \underset{\text{(Water)}}{H_2O}$$

b. Whenever certain sugary substances undergo a certain type of fermentation there is formed, among other things, carbon dioxide; so

when your fruits and fruit juices "work" (as some people always designate this type of fermentation) the frothing on the surface, and the development of pressure within the container (if it be a closed one), is due to the carbon dioxide formed. Likewise, when bread and other food products are made with the use of yeast the so-called "raising" or "rising" is caused by the formation of carbon dioxide throughout the mass of the mixture or dough. In the "curing" of ensilage in the farmer's silo this gas is formed, and some fatalities have have resulted from persons (either not knowing or overlooking this fact) entering such a silo without first giving it a thorough ventilation. Decaying vegetation in the presence of water, as in the bottoms of old wells, sometimes forms this gas; hence it is unsafe for a person to descend into wells or pits without first having tested the air of the well or pit. This can be easily done by lowering a lighted lantern—if the flame is not extinguished the amount of carbon dioxide present is insufficient to make the air unsafe to breathe.

c. Whenever any form of carbon, such as coal, coke or charcoal (yes, and diamonds or graphite), is burned in oxygen or with its aid, carbon dioxide is formed. Air contains about 20 per cent. oxygen, and this is quite sufficient to permit the combustion of coal, coke and charcoal, but not of diamonds or graphite. If combustion is incomplete, carbon monoxide is generally formed. The commonest cause of incomplete combustion is an insufficient supply of air (hence, of oxygen), and coal, coke and charcoal fires have to be carefully regulated to prevent the presence of carbon monoxide in the final products of combustion. When carbon burns to carbon monoxide only about one-third the heating value is obtained, the other two-thirds being realized when monoxide burns to dioxide, and this is the very best reason for aiming to regulate fires in such a manner as to have only the dioxide going up the chimney.

d. Whenever any compound of carbon burns in air or oxygen, carbon dioxide is among the gases formed if the combustion is complete. Sometimes carbon monoxide is formed, especially if the oxygen supply is low, but very often the carbon not burned to carbon dioxide is separated in the free state and known commonly as soot. Among the most familiar substances used for fuel, or for lighting purposes in many instances, which are compounds of carbon, or mixtures of such compounds, are wood, gasoline, kerosene, fuel oil, natural gas, artificial gas, fats, waxes, wood alcohol, grain alcohol, etc. Here again the aim should always be to so conduct the combustion that carbon

dioxide will be the only carbon compound among the final products of combustion.

A few simple tests will suffice to demonstrate the formation of carbon dioxide in the combustion of carbon compounds of various kinds. We will moisten the inside of each of a number of goblets with lime water and hold one each for a few moments over the flame of (a) a match, (b) an oil lamp, (c) an alcohol lamp, (d) a gas jet, (e) a candle. In each case we note the development of a turbidity in the drops or film of liquid adhering to the inside of the goblet, the turbidity being due to calcium carbonate formed by the action of carbon dioxide on the calcium hydroxide of the lime water, as explained earlier in this discussion.

e. Most carbonates, when strongly heated, decompose, the products of decomposition being carbon dioxide (which comes off as a gas) and a metallic oxide (which remains in the vessel in which the carbonate has been heated). A very common example of such a process is the so-called "burning" of limestone, chalk, oyster shells, marble, and other forms of calcium carbonate to produce "lime," "burnt lime," "quicklime," or "stone lime," which are names given by farmers, builders, whitewashers and others for what the chemist knows as calcium oxide. The latter pictures the reaction that takes place with the equation:

$$\underset{\text{(Calcium Carbonate)}}{CaCO_3} + \underset{\text{(Heat)}}{\triangle} \longrightarrow \underset{\text{(Calcium Oxide)}}{CaO} + \underset{\text{(Carbon Dioxide)}}{CO_2}$$

In the occasional production of lime, as on a farm in a limestone section of country, the carbon dioxide is allowed to escape into the atmosphere; in industrial plants where the production of lime is a regular process the carbon dioxide is generally collected, to be used about the plant or to be sold to some other concern.

The production of a fine grade of litharge (lead oxide, PbO) from lead carbonate ("white lead"), the making of "zinc white" (zinc oxide, ZnO) from zinc carbonate, the manufacture of "magnesia" (magnesium oxide, MgO) from precipitated as well as native magnesium carbonate, are other utilizations of the effects of heat on carbonates. There are many others.

f. When ammonium carbonate (so-called "baking ammonia") is heated it gives off two gases, ammonia (NH_3) and carbon dioxide (CO_2), as some of the ladies present may know from their experience in baking certain kinds of cookies. At least they know of the production of the ammonia—if their respective noses are functioning as they should.

g. Whenever bicarbonates are heated, even moderately, they decompose, evolving carbon dioxide and leaving a residue of a carbonate. The speaker has known of instances where the housewife put sodium bicarbonate (she knew it as "baking soda") into a cake or biscuit batter and forgot to add sour milk, cream of tartar, or other acidic substance. Results are anything but gratifying. The mass lightens somewhat in the baking process, the heat effecting the liberation of half of the possible carbon dioxide and expanding it, but, oh, the taste of the finished product, because of the sodium carbonate (same thing as "washing soda") in it.

h. Whenever an acid or acidic substance comes into intimate contact with a carbonate or a bicarbonate, as in the presence of water, a chemical reaction ensues in the which there is formed a salt of the acid, and carbon dioxide is given off. Often the prime object of such a process is to get the salt, and the carbon dioxide is allowed to escape as being of no importance. In other instances the carbon dioxide is the substance wanted and the salt is of little or no importance. We shall cite a few illustrations:

1. The pharmacist usually makes his solution of citrate of magnesia from magnesium carbonate and a solution of citric acid, allowing the carbon dioxide to pass off; the solution is all he wants. But he uses more of the acid than is needed to decompose the magnesium carbonate, and, just before he delivers a bottle of the solution to a customer, he puts into it some sodium bicarbonate or potassium bicarbonate, which reacts with some of the excess of citric acid to produce a citrate (not the chief substance wanted) and carbon dioxide. The latter, being a gas, develops pressure in the tightly closed bottle, and when the customer opens the bottle he has an effervescent, more or less agreeable, mixture to drink.

2. Consider now the seidlitz powder, often used "the morning after" to help clear away the effects of "the night before." The blue paper contains an intimate mixture of Rochelle salt (the medicament) and sodium bicarbonate, while the white paper contains tartaric acid. When the contents of the papers are dissolved in separate portions of water and the two solutions are then mixed, there results a "fizzy" mixture which is not hard to take. The "fiz" is due to the carbon dioxide (the chief substance desired).

3. Bromo seltzer is an example of a class of preparations in which we have usually a mixture of one or more medicaments, a carbonate (usually sodium bicarbonate), and an acidic substance (tartaric acid

or acid potassium tartrate generally). So long as one of these preparations is kept dry there is no reaction (incidentally, no deterioration), but when mixed with water the carbonate and acidic substance react with each other to form the carbon dioxide needed to give the desired efferversence.

4. Baking powders are similar to the preparations just considered, except that they contain no substance intended for medicinal use, or intended to produce one of medicinal value. However, every product in the making of which a baking powder is used has in it something that often is used as a medicine, but the amount is so small that one need not refrain from eating a large piece of cake because of any possibility of getting a pronounced physiological action. Baking powders are intimate mixtures of dry powders, of which sodium bicarbonate is almost always one (this to furnish carbon dioxide), and some substance (usually acidic), usually diluted with starch. Here are some of the combinations:

a. Sodium bicarbonate and cream of tartar (potassium bitartrate)—sometimes tartaric acid.
b. Sodium bicarbonate and monocalcium phosphate.
c. Sodium bicarbonate and one or another of the several alums.

All of these are inactive when kept dry, but when allowed to become even slightly damp gradually deteriorate. When mixed with milk, water or watery mixtures, the constituents react with each other to form a compound which remains in the finished product, and carbon dioxide, which lightens the mass while still cool, expands greatly in the baking to lighten the mass still further, and dissipates into the atmosphere during the baking, or thereafter. When a cake "falls" it is because the gas has escaped before the baking has proceeded far enough to toughen the mass of dough sufficiently to enable it to stand alone—that is, without the support of the gas enclosed within its pores. This is apt to take place when the batter is thin. Opening the oven door may cause a cake to "fall," because the inrush of cooler air from the outside causes the gas in the cake mass to contract.

Reference has been made to the production of substances having medicinal action in the decomposition of baking powders. Tartrate baking powders (Type a) produce Rochelle salt; phosphate baking powders (Type b) produce sodium phosphate; alum baking powders produce sodium sulphate (generally known as Glauber's salt). All of these are cathartic when taken in considerable quantities. However

much little Johnnie would enjoy taking his physic in the guise of cake, it takes too much to bring about the desired results. Johnnie would not object, however.

i. When nitroglycerin, dynamite (nitroglycerin absorbed in a solid), guncotton (nitrocellulose), T. N. T. (trinitrotoluene), picric acid (trinitrophenol) and other so-called "high explosives" explode, both carbon dioxide and nitrogen—sometimes oxides of nitrogen—are produced. This must be taken into consideration by workers who have to clear away the debris, particularly when the explosion has taken place in a pit, mine or other enclosed depression. They should be sure that these gases have been dissipated before entering such places.

j. When "fire damp," which is a mixture of methane (CH_4) and air, in coal mines explodes, the composition of the so-called "after damp" varies according to the proportions of methane and air existing in the explosive mixture:

1. A mixture of one volume of methane and ten volumes of air produces carbon dioxide and nitrogen when exploded. Both are asphyxiants and all miners not killed by the shock of the explosion are promptly asphyxiated.

2. With a mixture of less than ten volumes of air to one of methane the gases produced are nitrogen, carbon dioxide, carbon monoxide. The first two are asphyxiants, the last one acts both as an asphyxiant and a blood poison. Miners have no chance of escaping death.

3. With a mixture of more than ten volumes of air to one of methane the gases produced are carbon dioxide and nitrogen, but admixed with them is some oxygen, the life-supporting element of the atmosphere. The chances of the miner escaping death by suffocation are good or poor, depending upon how many more than ten volumes of air to one of methane were present in the explosive mixture.

k. When carbon monoxide burns in air, carbon monoxide is produced. We shall try to show you this with some carbon monoxide which we produced this afternoon by the action of concentrated sulphuric acid upon formic acid. The equation which illustrates the reaction is

$$\underset{\text{(Formic Acid)}}{HCOOH} \longrightarrow \underset{\text{(Carbon Monoxide)}}{CO} + \underset{\text{(Water)}}{H_2O}$$

The function of the sulphuric acid is that of a water-remover (the chemist calls it a "dehydrating agent"). Some of the gas has

been collected and preserved over water, being practically insoluble in water. You will notice that it is colorless, and it is also free from odor. It should not be inhaled because it is very poisonous, attacking particularly the hæmoglobin of the blood and taking away from it its power to "carry" oxygen. Half of one per cent. in air is fatal to man and animals if inhaled for some minutes. Greater concentrations act more quickly. Its lack of odor makes it all the more dangerous. If it had odor people could detect its presence quickly and take necessary precautions to avoid being overcome by it. More will be said about its dangers later on in this talk.

Now we shall burn some of it. You notice the blue color and lambent or dancing character of the flame. Doubtless you have seen the same phenomena in a stove or furnace in which anthracite coal, charcoal or coke was burning. If so, you have actually seen carbon monoxide burning, perhaps, many times; for this is what generally happens with such a fire: air (to furnish the oxygen needed) enters under the grate and passes through the glowing fuel, the carbon of the fuel combining with oxygen to form carbon monoxide, which, along with the nitrogen from the air, escapes from the upper part of the mass of fuel. The equation which interprets what has taken place thus far is

$$\underset{\text{(Carbon)}}{C} + \underset{\text{(Oxygen)}}{O} \longrightarrow \underset{\text{(Carbon Monoxide)}}{CO}$$

It may not be amiss here to repeat that this reaction releases only about one-third of the heating value of the fuel. If air is now supplied over the mass of fuel, either through openings in the fire door of the furnace or in some other way, the carbon monoxide ignites and burns to carbon dioxide, and this reaction releases the other two-thirds of the heating value of the fuel. It is quite apparent that you must have flame if you would realize the maximum heating value from your fuel. Except with coarse coal it is practically impossible in the ordinary furnace to get air enough through the fire-bed to effect complete combustion within the mass of fuel; so some air must be supplied over the mass. The construction of most furnaces and heating devices is such that it would be highly undesirable to have complete combustion taking place in the fire-bed, but, rather, there should be only enough air passed the fire-bed to insure the conversion of carbon into carbon monoxide, which gas should then be burned above the fire-bed or beyond it in such a way that the flame should come into immediate contact with the part of the heater which is responsible for the so-

called "heat transfer" (the "tubes," etc., of steam and hot-water systems, the "drums," pipes, etc., of hot-air systems). For best results the air control should be such as will produce the longest possible flame. Short flame usually indicates too great an air supply over the fire-bed, the immediate effect of which is to lower the temperature of the gases which are to come into contact with the surfaces of the heating unit, and that means a waste of fuel. The effect is comparable with that produced on hot dishwater when cold water is run into it. Most of you know how quickly the steam "goes down" in the radiators of a steam heating system when the fire in the furnace is checked by opening the fire door. Let us do a little calculating. Let us suppose that the temperature over the fire of a heating system is 600 degrees Fahrenheit (a low estimate); now let us open the fire door and let in one volume of excess air at 60 degrees for every four volumes of the hot gases produced by the fire. Result: Four volumes at 600 (2400) plus one volume at 60 equals five volumes (2460), or an average temperature (2460 divided by 5) of 492 degrees—a drop of 108 degrees. Now, let us suppose that the inflow of excess air was equal in volume to the volume of gases produced in the combustion, in which case our calculation will be: One volume at 600 and one volume at 60 will produce two volumes at an average temperature (660 divided by 2) of 330 degrees. It is very obvious that the heating surface in any heater will not get as hot from a stream of gas at 330 or 492 degrees as from one at 600, and that checking a fire by opening the fire door of the furnace is very poor practice. Every properly equipped heater should have in the smoke outlet a door which can be opened or closed at will. Opening the door weakens the chimney draft and hence checks the fire without wasting the heat produced by what fuel is burning. Further checking can be effected by closing, or nearly closing, all ash pit openings and other openings through which air can get to the mass of burning fuel. The smoke outlet should be equipped with a damper, which damper should be wide open always, except where there is a very strong chimney draft. Never should it be completely closed, for that forces the gaseous products of combustion out of the furnace into the surrounding atmosphere, with danger of asphyxiating every living being in the house if these gases can get to other parts of the building.* If the heating system is one in which air from a basement is heated

*Shortly after this lecture was delivered one of the most prominent pharmacists in the United States lost his life in this manner.

and sent upstairs through the hot-air ducts the danger is especially great.

It might be well at this time to state that hot-air systems of the type just mentioned cannot be expected to work satisfactorily if the basement is small and tightly closed. The fire must have air in order to continue burning, and other air must be heated and sent upstairs through the hot-air ducts, and fresh supplies of air must be provided to take the place of what is being thus used. Unless some provision is made for an inflow of air from outside of the room in which the heater is located the fire will burn poorly and no hot air will go upstairs. Open a window partly, or leave the door to the upper floors partly ajar. Cold air will flow down the basement stairs while hot air goes up the ducts. The draft in the furnace and the flow of air upwards through the heating ducts is due to the difference in relative weights of hot and cold gases, hot ones being lighter than cold ones and thus having a tendency to rise; but when they rise other colder ones rush in to take their places. You cannot draw air out of a tightly closed room indefinitely, any more than you can suck it out of a bottle by putting your mouth over the mouth of the bottle and applying suction. If you put a tube into the bottle, the tube being small enough in diameter to permit the inflow of air between the outer walls of the tube and the inner walls of the neck of the bottle, you can draw out air indefinitely, as what is drawn out is promptly replaced by new air. The same thing applies to your heating system.

Another thing which strongly influences the efficiency of any hot-air heating system is the degree to which the rooms being heated permit an outflow of air. If doors and windows are tightly closed, especially when windows are weather-stripped, hot air cannot be freely forced into such a room, as something of a back pressure is developed. It is very much like a crowded street car—once it is full you cannot crowd more into it, but if some persons are let out others can come in. Loosely fitting windows and doors have many things to their credit. Doubtless many persons are alive and quite well today who would have been in their graves long ago had all windows and doors in their dwellings always fitted closely. When they fit but loosely air can get in or out relatively easy, and change of air is effected without causing perceptible drafts. To demonstrate the truth of what has been said about the futility of trying to force air into a closed room, we can reverse the procedure of our last test. When we apply the mouth to the mouth of a bottle and try to blow more air into it we

fail, but when we put a tube into the bottle and blow through the tube we can do so indefinitely, because air already in the bottle is forced out by what is being blown in through the tube.

We shall go back to our demonstration. You saw the burning of the carbon monoxide. Now, we shall prove that carbon dioxide was formed by use of the lime water test.

You have seen that carbon monoxide burns, but how about carbon dioxide? We have some here that was made from a carbonate and an acid. We shall bring the flame of a lighted paper into it. You notice that the flame is promptly extinguished.

Carbon monoxide has about the same density as air, but carbon dioxide is heavier—about half again as heavy. We have here a vessel which is empty except for the air it contains, as may be proved by testing it with a lighted taper. You will note that the flame is not extinguished. Now we shall pour some carbon dioxide into it, just as we might pour in a liquid. Of course, there is some mixing of the carbon dioxide with air already in the container, but we think enough of the gas will go to the bottom to displace most of the air. Let us test the gases in our container with the lighted taper. The flame is promptly extinguished. A practical application of what we have just shown is the use of chemical fire extinguishers. Many types depend for their efficiency upon their ability to deliver carbon dioxide into the burning materials.

CARBON DIOXIDE—POISON!

We have seen that carbon dioxide does not support combustion. Neither does it support life. It is not poisonous like carbon monoxide, but we cannot breathe it long without losing consciousness, and if breathed too long it causes death by asphyxiation. Rather large percentages of it in air can be inhaled for long stretches of time without permanently serious results. As high a concentration as 50 per cent. has been breathed for a few minutes without untoward results, while as low a concentration as 8 per cent. breathed for a long time has produced fatal results. Generally speaking, if a person overcome by carbon dioxide can be restored to consciousness and supplied with fresh air, recovery is speedy and complete; while persons overcome with carbon monoxide and restored to consciousness may be months or even years, in recovering completely, and not infrequently has death ensued weeks after apparent recovery of the patient.

The heaviness of carbon dioxide adds to its possibilities for doing harm to man. Were it lighter than air it would soon rise and be dis-

sipated into the surrounding air. A few of the ways by which it has caused death may be cited.

a. A limekiln beside the road is in operation and carbon dioxide is escaping from the top, the wind blowing it away as it escapes; a homeless wanderer comes along; the evening is cool; here is a warm place to sleep; he lies down beside the kiln and dozes off. The wind dies away, the carbon dioxide is no longer blown away but settles about the sleeper and displaces the air he should have; he breathes the carbon dioxide, and shortly his troubles and wanderings are at an end for all time.

b. A man buys a farm on which is located an old dug well that has not been cleaned out for a long time; in the bottom is a mass of decaying vegetable matter which he decides to clean out, descending into the well for the purpose; later on some of the neighbors fish out his body; in a few days it is laid away in the churchyard and another widow is left to fight not only her own battles but those of her children in a not too charitable world; all because he did not think or know enough to lower a lighted lantern into the well to determine whether or not the air in it would support life. Wells in limestone regions may collect carbon dioxide, as rain water percolating through the limestone converts some of it into a soluble so-called "bicarbonate of lime" which decomposes, when it gets into the open, into insoluble calcium carbonate and carbon dioxide. The heaviness of the gas causes it to stay in the lower levels of the well.

c. Two silos were standing side by side and connected by a passageway; one contained fermenting ensilage, while the other was apparently empty. Two boys were playing on the roof of the empty silo and one dropped his shoe through a hole in the roof. There was a ladder down the inside and he descended to get his shoe; he was overcome and the other boy went after him. The father being near, spread an alarm and a farmhand responded, tied a wet handkerchief over his mouth, opened a door at the bottom of the silo, rushed in and brought out both boys—now dead—then collapsed himself, but was speedily restored to consciousness.

CARBON MONOXIDE—POISON!

Mention has been made of the poisonous effects of carbon monoxide. It may not be out of order to cite a few incidents to emphasize its dangerous character and call attention to some of the conditions under which it is formed. At this time of the year (January) hardly a day passes that one does not find in his favorite newspaper at least

one account of fatalities due to one or more causes similar to those we shall mention. In summer we see but few such accounts because hot weather prompts people to keep their homes, workshops, garages, etc., open, and heater fires are not in operation.

a. A young man, aged nineteen, is dead in Schuylkill Haven after being suffocated by motor exhaust fumes in his father's garage. His body was found leaning against the door (so rapidly does carbon monoxide act). The chief cause of death was carbon monoxide poisoning, doubtless, though it is likely that carbon dioxide was present in dangerous quantities, and, of course, nitrogen (a suffocating gas) was present.

We have somewhere seen the statement that over 700 persons lost their lives in this country during 1927 in a similar manner. The engine of an auto should never be allowed to run, even for a minute, in a closed garage. The door should be opened wide before the engine is started and not closed until it has ceased running.

b. A man in Overbrook the other day entered his garage to run out his car. He had not yet started the engine when he noticed himself getting faint. He managed to get to the door and soon felt somewhat revived, but has not felt altogether right since. After getting his wits together he remembered that he had started a fire some hours before in a flueless gas stove. The garage was fairly near airtight, the oxygen in the air of the garage was soon used up in large measure by the fire, and what he probably breathed was chiefly a mixture of carbon monoxide, carbon dioxide and nitrogen.

c. A young man of meager means occupies a small room which is heated by a flueless gas stove and lighted by a gas jet; it is a cold night and he decides to stay away from the movies to read a while and then go to bed. He lights the gas in the stove and the gas jet and starts to read; the light is poor and he dozes off; the burning gas soon uses up enough of the oxygen in the room to make the air a non-supporter of combustion, and both flames are extinguished; but the gas flows on through stove and jet, adding carbon monoxide and other gases to the already dangerous mixture in the room. Another lodger on the same floor smells gas when he comes in some hours later, and investigates, only to find the young man dead. He calls the police, who promptly appear and begin to check up. One notes that paper had been stuffed into some of the cracks of the not too tightly fitting window. "Aha! Cracks stuffed up, both gas valves open, fire out, evidences of poverty. Plain case—suicide." We wonder how many unfortunates are an-

nually consigned to suicides' graves through ignorance on the part of officials, and sometimes physicians, of simple chemical reactions. Occasionally the victim is given the benefit of the doubt by the statement, "He is supposed by the police to have accidentally bumped his hand (or foot) against the gas valve," or something similar to this. Gas stoves having no flue connections to the out-of-doors, "hot plates," and even gas lamps and gas-heated smoothing irons are dangerous to use in unventilated rooms, particularly small rooms. Oil stoves and oil lamps are not apt to produce carbon monoxide in quantity, but they use up oxygen rapidly and in unventilated rooms the burning oil tends to produce an increasing amount of smoke or soot (unconsumed carbon). In our time we have seen a number of rooms that had recently been given a thorough accidental smoking from oil stoves, and one instance where the smoking was done by a big Rochester oil lamp, left burning for only a few minutes while the occupant was elsewhere in the house.

d. A few years ago some half dozen Russian prisoners were being transferred from one prison to another in a closed auto sleigh. It was a cold night and the drivers being not altogether "hard boiled," thought to warm the prisoners and turned some of the exhaust gas into the compartment occupied by them. At the end of the journey the prisoners were found to have flown, though their bodies were in the sleigh.

e. It is not necessary to have constricted space to have fatalities from auto exhaust gases. The other day some of the papers told how a woman in one of the western States committed suicide by lying down on the ground near the exhaust of her car. Had the victim been of the opposite sex we would feel disposed to say that some police official has made snap judgment again, but women do not often "get out and get under," so we shall have to accept the verdict as rendered.

f. In some steel mills certain furnaces are heated with burning "producer gas" (rich in carbon monoxide), and, occasionally, accidents have happened, resulting in the escape of quantities of this gas into places where men were working and a dozen or more of them have been overcome from its effects. Up-to-date steel mills where this is apt to happen keep on hand apparatus of the pulmotor type with a plentiful supply of cylinders of oxygen mixed with some carbon dioxide, it having been found that this mixture is more effective than pure oxygen in the treatment of cases of carbon monoxide poisoning.

STREET DANGERS

Because of the large percentage of carbon monoxide in the exhaust gases of automobiles, the large number of motor vehicles in the downtown sections of our large cities, and the poisonous characters of this gas, there has been considerable speculation on the part of thinking people as to the possibilities of harm coming from the breathing of the air around busy street crossings (especially on calm days), or the air of vehicular tunnels like the Holland Tunnel between New York and New Jersey, or of the Fifteenth Street tunnel at our own Broad Street Station, and of the lower floor apartments along busy thoroughfares. It is claimed that babies and young children generally are more susceptible to the ill effects of carbon monoxide than adults, and, certainly, traffic officers would be in more danger than other people. The United States Bureau of Mines and the United States Health Service have recently completed a study of the effects of carbon monoxide, both on the physical and mental makeup of six healthy individuals, and have reached these conclusions:

A concentration of 1 to 4 parts carbon monoxide in 10,000 parts of air breathed for four to seven hours a day every day for sixty-eight days had no effect on the health, appetite, weight, mind or muscle of the people; but symptoms of poisoning (headache, dizziness, faintness) showed with some of them after three to four hours, particularly with the 4 to 10,000 concentration. A concentration of 2 to 10,000 is considered perfectly safe, and, so far as the speaker knows, in no case where the air from places corresponding to those mentioned has been tested has a greater concentration than this been found. Carbon monoxide is slightly lighter in density than air at the same temperature, while the hot gas that comes out of the exhaust pipe of the automobile is still lighter and would thus have a tendency to rise rapidly and correspondingly reduce the probability of dangerous concentrations being formed at street crossings. Besides, the rapid movements of the vehicles has a tendency to create currents which dissipate the gas into the air, and even a moderate breeze is quite sufficient to carry it away. The idling motor would seem to be a far greater source of danger than the motor of a machine moving along the street.

GOOD TRAITS

In our talk thus far we have stressed rather strongly the bad characters of the carbon oxide brothers, and only incidentally touched upon their good traits. Like most humans, they are capable of doing much good in the world, which

good more than compensates for their bad qualities. We shall try to give you just a few.

a. Carbon Monoxide.

This compound has been referred to in our discussion of fuels (particularly anthracite, coke and charcoal) as being formed in the first stage of the combustion of these. It is often purposely produced to be used as a fuel gas where natural gas cannot be obtained, and where solid and liquid fuels cannot be used directly.

What is known as "producer gas" is formed by the partial combustion of anthracite or coke through blowing air through large quantities of the ignited fuel. It is primarily a mixture of nitrogen and carbon monoxide, the latter being the valuable constituent of the mixture. In certain types of furnaces used for the manufacture of steel, and often for heating the so-called "tanks" used in making glass, this gas is largely utilized.

What is known as "water gas" is a mixture (about half-and-half) of hydrogen and carbon monoxide, both of them capable of producing high temperatures when burned. It is generally made by bringing coke to a bright stage of incandescence and then blowing steam through it. The reaction is expressed by the equation:

$$\underset{\text{(Carbon)}}{C} + \underset{\text{(Water)}}{H_2O} \longrightarrow \underset{\text{(Carbon Monoxide)}}{CO} + \underset{\text{(Hydrogen)}}{H_2}$$

Carbon monoxide combines easily with a number of the other chemical elements to form compounds many of which are useful to man. It combines with chlorine to form phosgene ($COCl_2$), a poisonous compound used in the World War in "gas warfare," but capable of reacting with many other compounds to form substances of benefit to mankind. Urea, a substance now largely used as a fertilizer, is often made by treating phosgene with ammonia.

Carbon monoxide can be made to react with hydrogen to form methanol, formerly gotten chiefly from the destructive distillation of wood (hence the name "wood alcohol"), which is a valuable solvent and also capable of being converted into a host of derivatives, some of which have medicinal value, or dyeing value, or find application in the perfume industry, or other industries that favorably affect human life.

b. Carbon Dioxide.

This compound has been referred to as the source of the "fiz" in soda water and other carbonated beverages, and as the cause of the

porosity in bread, cake and many other comestibles. A comparatively new use for it is a refrigerant, taking the place of ice and marketed under such names as "dry ice," "carbon dioxide snow," "carbonice," etc. The solid form is used and heat is absorbed in the vaporization of the solid. It does not pass through a liquid phase as ordinarily used, giving it decided advantages over ice for many purposes. The degree of cold produced is decidedly lower than that capable of being produced with ice and salt. The speaker has been informed that certain manufacturers and distributors of ice cream have practically given up the use of ice, and are using solid carbon dioxide instead, particularly for shipping package purposes. Some of the transcontinental railroads are using it in place of ice for long-distance hauls, particularly as its use does away with the necessity of frequent side-tracking of the refrigerator cars for "re-icing." The speaker has heard of no fatalities attending its use for refrigeration purposes, but sees possibilities of workmen being asphyxiated from the gaseous form through entering unventilated chambers where it has been accumulating.

The annual consumption of soda water (plain or flavored water, saturated with carbon dioxide), especially by Americans, is enormous, yet many people can get along very nicely without it, and millions have never known anything about it; but nothing more disastrous to the human race could happen than the sudden stoppage of the combination of carbon dioxide and water effected by plants. Under the influence of sunlight, plants convert carbon dioxide from the atmosphere and water from the earth into sugars and starch for our food, cellulose for our clothing, wood for our dwellings and furniture, and hosts of other substitutes for our pleasure.

In the hour at our disposal we have tried to give you some light on the characters of two members of the chemical family. We hope that what we have told you will give you a greater appreciation of their usefulness to man than you ever had before, and that what we have said of the unfavorable sides of their respective characters may have so put you on your guard that neither of them will ever be able to harm you.

THE HISTORY AND MYSTERY OF PYROTECHNY

By E. Fullerton Cook

PYROTECHNY DEALS with the artistry of fire whether natural or created by the ingenuity of man. It has been the admiration and wonder of all ages. Perhaps this is because fire is the physical evidence of a cosmic force out of which terrific heats were moulded all created worlds.

E. Fullerton Cook

It is appalling to contemplate the temperatures of a world in flux. We respond to the agreeable warmth of a winter's sun or the crackling fires of an open hearth, yet how quickly the destructive forces of fire, when out of control, bring terror to the heart and destruction in its trail! How dependent is organic life upon the maintenance of a temperature within comparatively narrow limits and this regulation is the more marvelous when it is realized that temperatures beyond imagination exist today in the sun and distant stars.

SYMBOLISM OF FIRE

Is it strange that the earliest records of man's consciousness evidence his belief that fire is symbolic of God? Perhaps his first knowledge of fire came from the lightning's stroke, crashing into giant forests and igniting the timber. Here was recognized infinite power, mysterious in origin, and awing in brilliancy and magnificence. Doubtless the accompanying thunders added to this effect.

It is not strange, therefore, that he who controlled the fires of primitive people became the priest, the representative of the God who held the destinies of the people within his divine will. These almost universally used fire as an evidence of their power and of the spiritual presence. In fact this remains today a potent force in modern religion and for symbolizing a spiritual presence. It has been used in our most effective war memorials as a symbol of the "eternal force" in the heart and life of the patriot.

The very word which indicates God in every language has its meaning within the thought of fire or light. The legends of almost

every people tell of the gifts or theft of fire from the gods. This is true of the Hindu story of the God *Devas* who with the evil spirit Asuras worked the fire drill upon Mount Mandara, until from its crest blazed the lightning. The Norse God Frodi was a god of fire, and his symbols were the sun, the lightning and flame. Thor was supposed especially to rule fire and Hermes was also a fire god and his Caduceus a fire wand. The Druid's worship of Be-al and the Phœnicians Ba-al both had the sun and fire as symbols and offered human sacrifices, to be consumed by fire. In Greek mythology fire was emphasized as the greatest gift of the gods and in Rome the "perpetual fires," burned on the altars of Vesta until Christianity swept aside the pagan forms of worship. And so we might trace through all antiquity and among every people the influence of fire and its symbolism of power and mystic force. Even in the Bible fire is repeatedly used as the symbol of God. The Garden of Eden was protected by angels bearing flaming swords. A pillar of fire by night and a cloud of smoke by day represented God as he led the children of Israel through the wilderness. God destroyed Sodom and Gomorrah with fire. Elijah was carried to heaven in a chariot of fire, while Jehovah was visible upon the Ark as a white flame and again in the burning bush. The Spirit of God descended upon the Apostles as tongues of fire.

Fire was thus exalted and feared and respected by primitive man more than any other recognized force and as civilizations developed, advantage was taken of this by the priests, who in handling fires, learned many of its mysteries and continually added to its effects and their power by new discoveries.

The civilization of Egypt was especially advanced in matters scientific. By their creative genius, they used nitrate of potash or saltpeter in intensifying the effects of their fires. It is even suggested that this knowledge may have spread from Egypt to India and China where nitre was also found. although many believe that the first fireworks were employed in these oriental countries.

Out of these beginnings of science there grew up the alchemist of the middle ages who for many centuries passed along the secrets of the profession and slowly added new discoveries. Among these are names commonly recognized as pioneer contributors to chemical knowledge and acknowledged as still worthy of praise. In this group are Gebir, an Arab of the ninth century, Albertus Magnus, a Dominican friar of Germany of the thirteenth century who is credited with the invention of amalgams, Raymond Lully who first dissolved gold and

greatest of all, Roger Bacon, an Englishman also of the thirteenth century. The latter several times in his books, which still exist, refers to combinations of saltpeter, charcoal and sulphur, today the basis of many pyrotechnic substances and the combination from which gunpowder is made. He refers to it being then of common knowledge and use. About the same time Marcus Græcus describes a primitive form of rocket. Here are the first known references to gunpowder which so vitally influenced the destinies of nations in the years immediately to follow.

GREEK FIRE

Prior to this time, however, a substance had been in use in warfare which was the undoubted progenitor of this destructive agent. In the seventh century, Gallinicus, a Greek of Syria, had invented a combination of crude nitre (saltpeter or potassium nitrate), sulphur, pitch, and possibly camphor. This was melted together, woolen cords were rolled in a mass and, when ignited, thrown upon the enemies' ships or walls. This was known as "Greek Fire" and for 400 years its secret was jealously guarded by the Greeks and aided them greatly in attack and defense. It is believed, from descriptions and records, that this substance was used in the defenses of Constantinople about 600 A. D. Marco Polo, in about 1270, also described the use of a similar substance in the wars of China.

While for centuries these inflammable mixtures have played an important part in the wars of all nations, there is no record of their use in Europe for entertainment or pleasure until the sixteenth century when Shakespeare frequently refers to "fireworks" and to "crackers" which "deafs our ears." These references, however, would imply that their use must have been rather common in his day.

THE FIRST FIREWORKS

The first recorded display of fireworks on a large scale was in honor of Anne Boleyn at her marriage to Henry VII in 1532. Here reference is made to a dragon "casting forth wild fire and men casting fire." The men who thus functioned carrying "fire clubs" and scattering "fire works" were known as "Green men" because they wore green branches about their heads for decoration and protection. One such is pictured on the title page of a book on pyrotechnics, written by John Bate in 1635 who claims to teach "most plainly and withall most exactly, the composing of all manner of Fire-works for triumph and Recreation."

Queen Elizabeth evidently enjoyed pyrotechnic displays for it is recorded that she attended one at Temple Fields, in 1572, when the

Earl of Warwick, then Master General of Ordnance, gave a sham battle in her honor. She is also recorded as attending displays at Kenilworth in 1572 and at Elvethan in 1591.

Pyrotechnic Displays.

Left to Right from Top: 1. A Set Piece of the Scenic Type. 2. Smoke Screen. 3. Old Book on Fireworks (1635). 4. Crystal Palace Fireworks. 5. Armistice Celebration, Hyde Park, London. 6. A Display of the Earliest Type (From a Print c. 1650). 7. Tercentenary Fetes, Quebec, 1908.

About this same time in Florence and in Venice and also throughout other parts of Europe, fireworks displays had gained great popularity. At this time it was customary to erect temporary buildings of elaborate designs and covered with plaster statues and figures, and on and inside of these to display various types of fireworks. In the

latter part of the sixteenth century these displays became associated with various church festivals, and were given annually in Florence at the Feast of St. John and the Assumption, and in Rome at the Feast of St. Peter and St. Paul or when a new Pope was elected. Often a high building was used as the background, such as the towers and fortifications of the Castle of St. Angelo in Rome, where the fire could be seen by the entire city. While the Italians were the first to adopt this type of fireworks, they soon became popular in Spain and France on church festivals and also in the celebration of victories or on some state occasion such as the marriage of the King or the visit of Royalty.

In France, during the reign of Louis XIV, the pyrotechnic art developed rapidly and elaborate displays were held on many occasions such as the return of the King to Paris in 1660 and the birth of the Dauphin in 1682, when displays were held in Paris, Dijon and Lyons. Louis XV especially encouraged the art. During this time, set pieces were developed and elaborate displays were made independent of a building where heretofore the fire mainly displayed scenic or architectural designs.

Records are available of many elaborate displays at the expense and under the stimulation of Louis XV such as the one at Versailles in 1739 in honor of the marriage of Madame La Premiere of France with Don Philippe of Spain, the birth of the Dauphin in 1730, the return of the King to Paris in 1745, the capture of Tourany and Chateau Grand in 1745, the taking of Ypres in 1747, etc. It is interesting to note that the French celebrated in this way the defeat of the English by the Americans. The celebrated pyrotechnic authorities in France during this period were Torre and the Ruggieri brothers. The latter were Italians from Bologna, but they became citizens of France and were largely responsible for the great improvement in pyrotechnic displays during this period.

Description and illustrations of elaborate displays in Germany, Austria and Sweden during this period are available and in many of them advantage is taken of the reflection from water which was early recognized as a means of enhancing the effect. At Versailles the extensive array of fountains was utilized. At Stockholm the displays were given by the sea and in London they usually were held by the Thames. An interesting description of such a display, in honor of the marriage of Prince Frederick to the daughter of James I, in 1613, reads as follows:

"first, for a welcome to the beholders a peale of ordinance like unto a terrible thunder ratled in the ayre . . . Secondly, followed by a number more of the same fashion, spredding so strangely with sparkling blazes, that the skie seemed to be filled with fire . . . After this, in a most curious manner. an artificial fire-worke with great wonder was seen flying in the ayre, like unto a fiery Dragon, against which another fierrie vision appeared flaming like to St. George on Horsebacke, brought in by a burning charger, between which was then fought a most strange battell continuing a quater of an howre of more; the dragon being vanquished, seemed to roar like thunder, and withail burst in pieces, and so vanished; but the champion, with his flaming horse, for a little time made a shew of a tryumphant conquest, and so ceased.

"After this was heard another ratling sound of Cannons, almost covering the ayre with fire and smoke, and forthwith appeared, out of a hill of earth made upon the water, a very strange fire, flaming upright like unto a blazing starre. After which flew forth a number of rockets so high in the ayre, that we could not chose but approve by all reasons that Arte hath exceeded Nature, so artificially were they performed. And still as the Chambers and Culverines plaide upon the earth, the fire-workers danced in the ayre, to the great delight of his Highness and the Princess.

"Out of the same mount or hill of earth flew another strange piece of artificiall fire-worke, which was in the likeness of a hunted Harte, running upon the water so swiftly, as it had been chaced by many huntsmen.

"After the same, issued out of the mount a number of hunting hounds made of fire burning, pursuing the aforesaid Harte up and downe the waters, making many rebounds and turnes with much strangeness; skipping in the ayre as it had been a usual hunting upon land.

"These were the nobel delights of Princes, and prompt were the wits of men to contrive such princely pleasures. Where Kings commands be, Art is stretcht to the true depth; as the performance of these Engineers have been approved.

"But now again to our wished sports: When this fiery hunting was exhausted, and that the Elements were a little cleared from fire and smoke, there came sailing up, as it were upon the Seas, certaine ships and gallies bravely rigged with top and top gallant, with their flagges and streamers waving liek Men of Warr, which represented

a Christian name opposed against the Turkes; where, after they had awhile hovered, preparing as it were, to make an incursion into the Turkish country, they were discovered by her Towers or Castles of defence, strongly furnished to intercept all such invading purposes, so sending forth the report of a cannon, they were bravely answered with the like from the gallies, banding fire and powder one from another, as if the God of battle had been there present.

"Here was the manner of sea-fight rightly performed; First, by assailing one another, all striving for victorie, the pursuing each other with fire and sword: The Culverines merilly plaid betwixt them and made the ayre resound with thundering echoes; and at last to represent the joyes of a victorie, the Castles were sacked, burned and ruinated, and the defenders of the same forced to escape with great danger."

Since these earlier and more primitive beginnings fireworks have lost none of their appeal to the masses. On many occasions, through the eighteenth and nineteenth centuries and also to the present time, displays of a more or less elaborate character have been presented in all countries, both in celebration of important events and as entertainment for the people.

The celebrations of victories or of peace have been the excuses for some of the most elaborate displays. They have also been a feature in the Coronation rejoicings of Kings and Emperors or have been made an attraction to visitors at great expositions and pageants. One of the most elaborate displays on record up to recent times was held in Green Park on the Thames, in London, in celebration of the Peace of Aix-la-Chapelle. It was directed by the famous Ruggieri who came especially from France for the event, which lasted for six hours. The frame was 114 feet high and 410 feet long and it displayed fixed suns, stars of six points and between each point a ray, cascades and pyramids (40 feet high). The chief piece was composed of a star of eight points, which then changed to a "royal brilliant wheel" whose fire was thirty feet in diameter and was moved by twelve fires.

Throughout the latter part of the eighteenth century and up to the middle of the nineteenth a number of pleasure gardens in London and vicinity conducted fireworks displays as one of their chief attractions. Napoleon, and later Louis Napoleon, were fond of fireworks, and on the occasion of the former assuming the title of Emperor of the French in 1804 the displays were original and elaborate. Na-

poleon was represented as mounted on a charger and seated on the summit of Mount St. Bernard.

When Queen Victoria visited the Paris Exhibition of 1855 a specially notable display of fireworks was given in her honor at Versailles and many other historic occasions throughout the century were celebrated by extensive displays in England and on the Continent.

After the erection of the Crystal Palace in London it became the centre of even more elaborate displays, the first in 1865 being of the nature of a competition among pyrotechnists. As these exhibits developed, set pieces up to 300 feet in diameter were displayed. Here exhibits were made regularly up to 1910 and again revived in 1920. Pictures in fire were set off 90 feet high by 200 feet in length and a favorite theme was a naval battle. The 1920 display was a reproduction of the Battle of Jutland.

In America the enormous pyrotechnic displays during the Philadelphia Centennial Exposition of 1876 were justly famous, and the other exhibits, such as one representing "The Siege of Vera Cruz" shown in various cities of the United States and those regularly made a part of every exhibition since the Centennial, indicates that fireworks are enjoyed here as much as in Europe.

The displays on the occasion of the celebrations of the Tercentenary of the founding of Quebec in 1908, is claimed to be the greatest fireworks display ever exhibited on this continent.

Many individual as well as city celebrations are annually a feature of the 4th of July or Independence Day demonstrations in our own country, although legislation is largely prohibiting the sale of explosive fireworks for individual use, due to the danger involved. To overcome the disappointment concerning this restriction, many communities are arranging for extensive municipal displays under trained directors.

Composition of Fireworks

Many substances have been used in formulas but the most important in use today are as follows:

Oxygen is necessary for fire, and while oxygen is present in the air and is responsible for the burning of wood or paper, larger quantities of oxygen must be instantly available in fireworks and therefore an oxygen-liberator must always be introduced. Also a substance must also be present which will readily combine with the oxygen liberated.

Nitre, Saltpeter or Potassium Nitrate: The chemical usually depended upon to supply oxygen is potassium nitrate, commonly known as "saltpeter" and this substance enters most formulas for fireworks and has been known for centuries in Egypt, China, and India. It was the most important ingredient in "Greek Fire," developed in the seventh century.

Gunpowder: This is composed of varying proportions of saltpeter, sulphur and charcoal and this combination is depended upon for most effects, although the ingredients are frequently only lightly mixed. When milled as they must be for the making of gunpowder, the combination becomes much more explosive.

Black Antimony was used in older fireworks for brilliancy.

Lampblack: This form of carbon when combined with saltpeter and sulphur produces a trailing effect, especially when mixed with arsenic sulphide (orpiment).

Potassium Chlorate: This oxygen-liberating substance was discovered by Berthollet in 1786 and the explosive character of the mixture produced by adding it to sulphur and charcoal was first evidenced by the death of two individuals in 1788 who tried the combination. Its chief value in fireworks. however, consists of its aid in producing colors. In 1838 Captain Meyer of the Prussian artillery published formulas suggesting its combination with various chemicals for producing colored fires.

For *green* he suggested barium nitrate, for *red,* the use of strontium nitrate, for *blue,* copper sulphate, for *yellow,* the carbonate or sulphate of soda. He pointed out that in all cases it is necessary to add potassium chlorate to properly bring out the colors. All of these substances are still in use today.

Steel Filings: Steel filings burn or oxidize readily and produce a sparkling effect as in the well-known "sparklets."

Powdered Magnesium Metal: This substance was introduced in 1865 and brought about the greatest advance in fireworks since the introduction of potassium chlorate and real colors. The further introduction of *powdered aluminium metal,* in 1894, was another notable advance.

These metals not only produce brilliant lights but are "burnables," replacing sulphur in many modern mixtures and greatly reducing the danger of spontaneous explosions.

Powdered Shellac: This organic substance adds to the combustibility of mixtures containing potassium chlorate.

Types of Modern Fireworks

SIMPLE FIREWORKS

Shells: These are usually shot from a mortar by an independent charge of powder and explode when at their maximum height, often producing a shower of stars in various colors.

Skyrockets: In this class of fireworks a charge, similar to gunpowder in proportion but less intimately mixed, is packed in a paper cylinder and attached to a stick which serves as a balance in its upward flight. The rush of fire and gas through a restricted opening propels the rocket, and it then usually bursts, scattering stars of color or of great brilliancy.

Ground Rockets: Similar in construction to skyrockets but fastened upon the ground and producing what is usually known as a Chinese tree or "flower pot." Usually iron filings are added to increase the shower effect.

Roman Candles: Why called by this name is unknown, but it seems to have been first used about 1805 in England and was probably named by an Italian. Its simplest form had been used for many years under the name of "Pump."

The early Roman candle was simply a tube filled with inflammable material which burned with a colored flame and could be carried in the hand. The modern form is made with a great variety of stars. Each charge consists of a "blowing charge" of fine gunpowder, a star, and then "dark fire," the latter consisting of a mixture of coarse gunpowder mixed with charcoal. These combination charges follow each other for the full capacity of the cylinder and a lighting fuse is attached at the end. The "dark fire" is first ignited, this fires the blowing charge which throws the star from the tube, which ignites it and causes a flash of color or brilliant flare.

Crackers: These and rockets are the oldest known form of fireworks. In crackers the gunpowder is tightly enclosed in a paper cylinder and fired by a fuse. The noise and explosion are the source of interest and enjoyment.

Some of the "giant crackers" of today are dangerously powerful and are generally prohibited by law, except when handled by professionals.

Saxon Lances: The saxon is a form of revolving display consisting of a single tube revolving about a nail driven through the tube at its center. The charge is ignited through holes placed at right

angles to the axis and on opposite sides of the tube and from which jets of fire project, causing the piece to revolve. These are charged with a mixture of mealed gunpowder, saltpeter, and sulphur and often a separate case, carrying colored fire, is attached to intensify the effect. This is fired simultaneously.

When the saxon is attached to a piece of curved wood and arranged to be shot into the air while revolving, it is called a *Tourbillion.*

The *Lance* is similar to the saxon and is the basis of all modern fixed or set pieces. They are about the thickness of a lead pencil and many thousands are used in building up a battle scene or a portrait when attached to the frame forming the outline of figures or designs.

COMPOUND FIREWORKS

To produce compound fireworks a number of the simpler forms are combined, usually in fixed sets.

Wheels: The rocket having been devised it was a simple matter to attach a number of these to a frame so mounted that they would form elaborate designs.

Fixed Suns or "glorys" consist of a series of rockets so arranged upon a fixed frame that the fire is thrown from the center in all directions. The character of the charge may vary so as to produce explosives or stars or brilliant lights, but the principle remains the same.

Fans are similar to suns except that the rockets are mounted in fan shape.

Mosaiques: These are geometrical designs arranged so that the fire will form symmetrical designs. *"Lattice poles"* are formed in this way.

Palm Trees: In these the rockets are attached to a frame which suggests a tree.

Bouquets: Arrangements less symmetrical but similar to the tree.

Cascades: These displays now are made up largely of powdered aluminum and at the Crystal Palace displays were often 90 feet high and 200 feet long.

Many special names are applied to varieties of the forms already mentioned and the alteration of design is only limited by the inventive genius of future designers of fireworks.

Torpedoes: These consist of a loose mixture of pebbles, and grains of explosive substances in a small paper package. They are fired by being thrown forcibly upon a hard surface.

It was the privilege of the writer to witness a fireworks display advertised as a special feature of the 450th anniversary of the Battle of Murten in Switzerland in 1926. Here on the Lake of Murten modern displays of rockets and colored fires vied with the gaily decorated and lighted small boats sailing on the lake, but the original and striking feature of the display was the placing of hundreds of candles in tumblers on the window sills of every house on the steep hill extending from the lake shore to the high bluff on which the village proper was built.

MILITARY PYROTECHNICS

This brief story would not be complete without a reference to modern military pyrotechnics. Doubtless the greatest stimulus through the centuries to the development of materials of this character has been the demands of war. "Greek fire" had purely a military application. The skyrocket was at one time an important means of attack and of setting fire to an enemies' ship or fort, and colored fires were used in signaling.

The World War also brought many hitherto-unthought-of uses to pyrotechnics. Among these were strings of colored fire at night in code and suspended by parachutes, colored smoke for day signaling, tracer bullets, the anti-Zeppelin bullets, the magnesium flare of one million candlepower to be shot from a gun and suspended by a parachute over the enemy trench area, and the "smoke screen" as a protection behind which one may retreat or attack. All of these were valuable aids. Recognition and illuminating lights were provided for airplanes. These were lighted electrically as they dropped through a tube. Incendiary bombs were constructed from thermite and thermalloy and produced unbelievable temperatures and were powerful weapons. In these the intense heat is accompanied by brilliant light, which adds to their value.

CIVIL USE OF FIREWORKS

Mention should also be made of the extensive use of pyrotechnics in everyday life. Signals at sea for identifying vessels, and sending messages are still important, notwithstanding the required wireless equipment of today. Rockets are extensively used by fishing vessels and by coast guards and life-saving organizations. Rockets are also used to carry the life-line over limited distances and has helped to save thousands of lives. On railroads, flares and rockets are constantly used to protect trains from collision and percussion caps placed on rails to indicate to an

approaching train the need for caution. In photography the magnesium flare is an essential equipment for the taking of many pictures. Smoke is used to protect fruit against frost, poison smoke to destroy insects, parasites and rats, and to these illustrations might be added many more.

ELECTRIC DISPLAYS

A few words must also be said about the modern use of fire for color effects in a form distinctly of our own age, that is electricity. Magnificent displays in color and on a gigantic scale never before dreamed possible, are today produced by powerful electric lights. These are being thrown, in some instances, upon fountains of water in varying forms and produce beautiful designs. The latest use of colored light is upon high buildings and even upon the sky where new and startling and most gorgeous effects are the result, far excelling the momentary colors and lights of a great pyrotechnic display.

And so our age enters a new era and a new source of colored lights and each new development is better and more lasting than its predecessor. What of the future? No one can predict except to wait and anticipate and in that is satisfaction and pleasure.

LITTLE DROPS OF WATER

Marin S. Dunn, Ph. D.

WATER IS one of the commonest substances we are acquainted with and one of the most necessary. Life could not continue very long in this world of ours were it not for the water present. Because this colorless liquid derived from two colorless, odorless gases—hydrogen and oxygen—is familiar to us in so many ways—oceans, rivers, lakes, ponds, wells, springs, etc., we are too prone to take it for granted and to give it scant consideration unless some special stimulus arises as for example when we are thirsty.

Marin S. Dunn, Ph. D.

However, water presents many problems. The chemist is interested in the solvent action of water and in the substances it contains; the physicist, in its color, turbidity, density and viscosity; the engineer, in harnessing its power to the will of man; the bacteriologist in a knowledge which leads to a control of the tiny, aquatic enemies and friends of man; the biologist, in a fuller realization of its importance to forms of life and in a study of the life cycles, reproductions and activities of the organisms found in this liquid world. Whether or not one is a scientist, philosopher, poet or artist, and no matter how much one thinks of or disregards the subject of water, when one is thirsty, the paramount importance of this widely-found substance is soon recognized and there are times when a cup of muddy, yellowish, sun-baked liquid is more precious than all the jewels of mother earth.

In this paper we shall consider water from the standpoint of the biologist. To begin with, let us review some of the uses of water to living organisms.

WATER AND LIFE

(1) Water is a necessary component of protoplasm, the living substance of both animals and plants. It varies in the different individuals, comprising over 50 per cent. of the weight of most animals. Analyses have shown the following percentages of water in crop plants.[1]

Clover plant, 78%.
Fresh meadow grass, 80%.
Dry hay, 14.3%.
Potato tuber, 75%.
Wheat grain, 14.2%.

(2) Water serves as a solvent of the gases and the salts which in solution enter the living cells.

(3) It is a necessary material for the manufacture of foods by green plants furnishing the essential elements hydrogen and oxygen.

(4) Comparatively speaking, it takes a great deal of heat to raise the temperature of water through one degree. Violent changes in temperature which might kill cells are thus prevented by the water they contain.

(5) It allows the cells to remain properly turgid or swollen—in the absence of this condition they could not function normally.

Having thus seen that water is absolutely essential to life, we will turn our attention to the small forms of plants and animals which are commonly found in the water of our ponds and rivers. Certain terms, often used in connection with these organisms, must now be explained. Plankton is a term (from the Greek word meaning "wandering") used to denote the large mass of floating organisms, drifting in the currents of streams and cast about by the waves of lakes. In contrast to this freely floating group, is the nekton (from the Greek word for "swimming") whose members have the power of changing their location by their own exertions. And finally, those organisms attached to or living on the bottom form the benthos (from the Greek meaning the bottom of the ocean). However, in many cases, plankton is popularly used to mean microscopic water organisms in general.

We shall now consider the subject under the following headings:

(A) Common groups of microscopic or almost microscopic organisms found in water.

(B) Seasonal distribution of microscopic organisms in ponds and lakes and certain factors involved.

(C) Natural agencies involved in the purification of streams.

(D) Conclusion.

(A) Common Groups of Microscopic or Almost Microscopic Organisms Found in Water

Organisms living in water may belong to either the animal or plant kingdom. It is the purpose of the next few pages to discuss briefly the different groups of plants and animals commonly found in water—particularly fresh water—and often to illustrate the entire group by taking as an example some well-known representatives. Large water forms are omitted from the following classification since it is our purpose to obtain a bird's-eye view of the smaller water life, often microscopic in size. It must be re-emphasized that certain waters may be freer of forms than others. Water that has been purified for drinking purposes may be almost devoid of organisms; other samples taken directly from ponds and lakes may be found teeming with life.

(A) *Animal Kingdom*

- (1) Protozoa
- (2) Sponges
- (3) Cœlenterata
- (4) Flat Worms
- (5) Unsegmented Round Worms
- (6) Wheel Animalcules
- (7) Moss Animals
- (8) Segmented Round Worms
- (9) Snails
- (10) Crustacea
- (11) Insect larvæ

(B) *Plant Kingdom*

- (1) Algæ
  - (a) Blue-green algæ
  - (b) Green algæ
  - (c) Diatoms
- (2) Fungi
  - (a) Iron bacteria
  - (b) Sulphur bacteria

(A) *Animal Kingdom*

PROTOZOA The protozoa are the simplest forms of animal life and they are nearly all invisible to the naked eye. Their name is derived from the Greek and means "first animal." In structure, the animals are single cells which must perform all the vital activities associated with more complex life—namely, metabolism, reproduction and response to stimuli. Let us study a common representative of the group, the Paramœcium (Fig. 3).

This tiny, unicellular cigar-shaped animal is just about visible to the naked eye. Extending backward from the front end of the body is an oblique groove which terminates just behind the middle. Little hairs (cilia), like tiny oars, are present all over the body, and by their beating the animal is able to move itself from place to place with remarkable speed.

At the inner end of the above-mentioned oral groove is a mouth, and little bits of food are swept by the currents of water created by ciliary movement in the oral groove into the mouth and down the short gullet or œsophagus (Fig. 3). Food vacuoles, consisting of small bits of food suspended in water, are formed at the inner end of the gullet and are carried away by the rotary movement of the protoplasm in the cell. Digestion takes place inside of the food vacuoles and the surrounding protoplasm absorbs the digested materials which finally become part of the living substance of the animal. In the food vacuoles there remain bits of undigested matter which are cast out of the body at a definite spot known as the anus. At each end of the body there is a clear vacuole present which is in communication with various portions of the body by means of radiating canals. Every ten to twenty seconds these vacuoles discharge their contents (urea, carbon dioxide) to the outside and thus function as excretory and respiratory organs. The term metabolism covers those operations which deal with the taking in of food, its digestion and assimilation and the breaking down of tissues and the casting out of the waste products.

Reproduction is accomplished in two ways by Paramœcium—the one is not sexual and results in a transverse division of the animal into two new individuals (fission), and the other is a sexual method known as conjugation in which there is an exchange of certain bits of the protoplasm of the nuclei of two individuals and the subsequent division of the animals by fission.

To various stimuli, Paramœcium responds either negatively or positively. For example, let us look at a Paramœcium which has received an injurious stimulus at its head end. "It reverses its cilia and swims backward for a short distance out of the region of stimu-

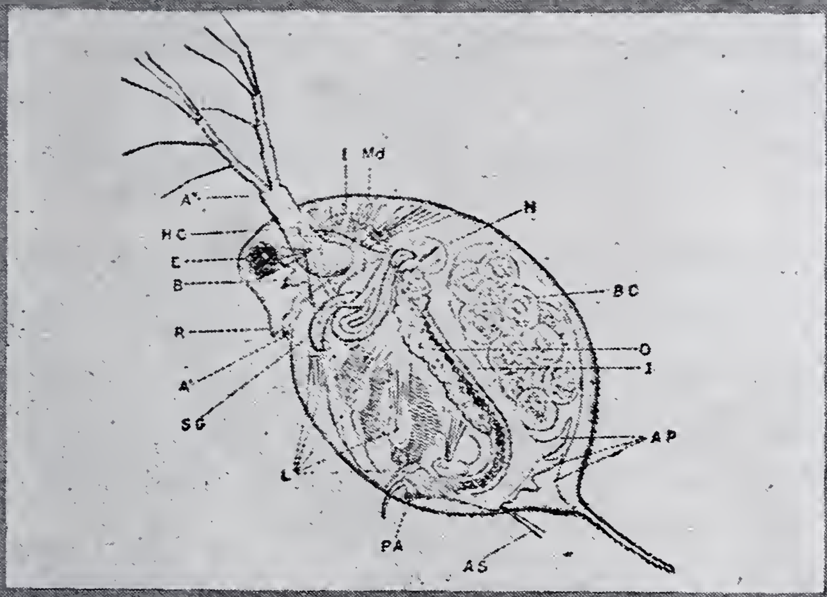


Fig. 1.

Daphnia longispina. A′, antennule; A″, antenna; B, brain with optic ganglion; BC, brood case with developing ova; E, eye; H, heart; I, intestines; L, legs; Md, mandible; O, ovary. (From Ward and Whipple after Sars.)

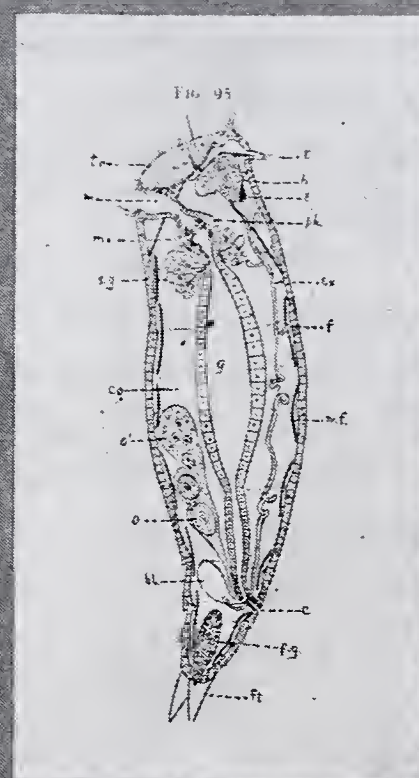


Fig. 2.

Rotifer. Diagrammatic drawing of sagittal section through body. b, brain; bl, excretory bladder; c, cloaca, the common opening of digestive and reproductive organs; co, body cavity; e, eyespot; ex, excretory canal; fg, foot gland; ft, foot; g, gut; m, mouth; mx, chewing stomach; ph, pharynx; o, ovary; t, tentacle; tr, cilia-bearing region; sg, salivary gland. (Taken from T. W. Galloway.)

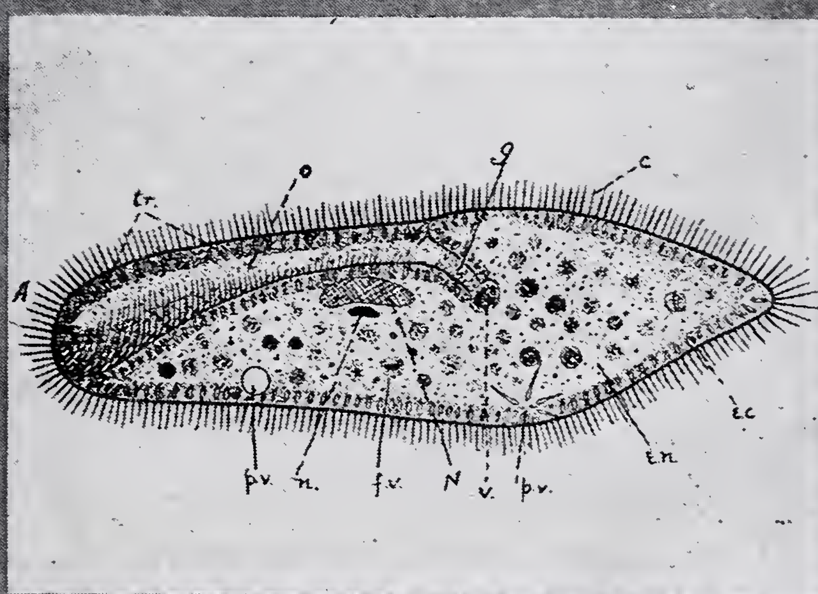


Fig. 3.

Paramecium in optical section (semi-diagrammatic). A, anterior end; c, cilia; e.c, ectosarc; f.v., food "vacuole"; g, gullet; N nucleus; o, oral groove, leading to the mouth; p.v., contractile vacuoles in different stages of contraction; v, food vacuole in process of formation. (From "Zoology," by T. W. Galloway, published by P. Blakiston's Son & Co.)

lation; then its rotation decreases in rapidity and it swerves toward the aboral side more strongly than under normal conditions Its posterior end then becomes a sort of pivot upon which the animal

swings about in a circle. During this revolution samples of the surrounding medium are brought into the oral groove. When a sample no longer contains the stimulus the cilia resume their normal beating, and the animal moves forward again." [2] There are various types of stimuli which Paramœcium is continually receiving and responding to. For example, there are always small objects in the surrounding water which Paramœcium touches. Changes in temperature affect the animal, and as a rule the optimum conditions lie between 24 degrees C. and 28 degrees C. In running water, Paramœcium swims against the current.

Thus we find in this small nucleated, unicellular animal, a form which, although relatively simple, is nevertheless an extremely beautiful example of how nature can produce in a single cell an intricate instrument which possesses the fundamentals of all living things.

Two other means of locomotion are shown by various members of the protozoa, and in fact, protozoa are classified on the basis of their method of locomotion. Among the sarcodina of which Amœba is an example, protoplasmic projections (pseudopodia) are produced from the cell and the protoplasm moves in the direction of the projection, thus giving the animals the appearance of oozing or flowing from place to place. In another distinct class are placed protozoans like the Euglena, possessing one or more long lash-like structures called flagella. Uroglena, often responsible for the "oily odor" of water, belongs to the latter group.

Most protozoa nourish themselves by finding, catching and eating other organisms. However, in this discussion, we must point out that there is a certain number of protozoa which possess green coloring matter called chlorophyll by means of which they are able to use the energy of sunlight to break CO_2 into its components carbon and oxygen and to unite the carbon with other chemical elements to build the constituents of their body. In other words, they nourish themselves as do plants. A third class of protozoa is able to live upon other dead and decaying organisms—that is it is saprophytic. Lastly, some protozoa are parasitic, living upon various other living organisms called hosts.

SPONGES

By far the greater number of sponges are marine, but a few are found in fresh water and because of their ability to form incrustations on the surfaces of water pipes, the group has been included in this discussion. Let us keep in mind also that although the fresh-water sponge does not look like the

sponges of commerce with which we are familiar, yet sponges have certain general characteristics in common, such as the presence of minute pores through the body wall, a central canal and supporting structures whatever their shape and chemical composition may be.

Let us focus our attention upon the fresh-water sponges represented by the greyish or greenish Spongilla. The body wall is composed of a mass of living cells supported by little rod-like needles of silicon and through this wall, extend minute canals which lead into little chambers whose walls are lined with peculiar cells possessing waving flagella which extend, one from the base of a collar-like projection of each cell, out into the chamber. From these flagellated chambers, canals lead into a central canal or gastral cavity which in turn communicates to the exterior through the osculum or mouth situated at the free end of the sponge's body. Water and food are taken through the pores in the body wall into the canals of the sponges and pass into the flagellated chambers where the food is engulfed by the collar cells and digested. Sponges are found more abundantly on the top and sides of water pipes in order to avoid being killed by the filling and clogging of their tiny pores by means of silt carried by the current.

Sponges often live where seasonal conditions are so adverse to their existence that they would die if they were not able by special provision to tide themselves over periods of hardship, *i. e.,* dryness or cold. Reproductive bodies called gemmules are formed in the adult sponge which consist of a ball of living cells protected by a wall. When favorable conditions return again, these gemmules germinate and develop into new sponges.

It should be noted in conclusion that sponges are many-celled animals as are the remaining animal forms which we shall consider.

COELENTERATA Living in fresh-water streams and ponds and found at times on the walls of mud filters and even on the beds is the curious little contractile Hydra which is the commonly-found fresh-water representative of a large group of animals mostly marine, the cœlenterata (Fig. 4). Hydra is really a hollow sac, attached at one end (the foot) and with a mouth surrounded by a number of hollow tentacles at the other. Two layers of cells make up the body wall; the outer layer is sensory and protective, and the inner surrounding the central cavity is formed of digestive, absorption and secretory cells. The food of Hydra consists of small aquatic

forms which are first paralyzed by little stinging cells which are especially numerous upon the tentacles of Hydra and then brought to the mouth by the tentacles which capture it. The food is then shoved through the mouth opening into the central cavity and digested.

Although invisible without complex staining methods, Hydra has been found to have a primitive nervous system with nerve cells in the outer layer which are connected by fibers to centers near the foot and mouth.

Hydra commonly reproduces by budding. In this process, a small protrusion in the body wall appears, and this bulge through elongation develops into a stalk which produces tentacles like the parent stalk possesses about its unattached end. Sometimes before the bud is detached, it may form other buds, thus giving rise to a colony. Occasionally the animal may reproduce by dividing itself longitudinally from mouth to basal disc. At certain times, sex organs may appear, the male organs being nearer the mouth, and reproduction is accomplished by fertilization.

One of the most remarkable facts about Hydra is its power to regenerate lost parts. If the animal is cut into two, three or four pieces, each one has the power to grow again into a complete animal.

FLAT WORMS

Fresh-water flat worms, represented in this paper by Planaria, are common in our lakes and streams and occur in many different types of environment from the shallow pools to the deeper lakes and are found during both winter and summer. As a rule, they may be collected on the under side of leaves and sticks, but some forms frequent the surface of the water. Planaria has a small, more or less flattened body; the head end is blunt and the tail end more pointed. On the upper surface near the head end are two eye spots, and the mouth is in the under surface near the middle of the body. In back of the mouth is the opening of the sexual tract. Glands secreting slime are present, and the surface of the body is covered with little hairlike projections called cilia.

There are certain interesting facts concerning the internal anatomy of Planaria. The digestive system consists of a mouth, a pharynx and an intestine which has three principal divisions each of which gives rise to a number of lateral branches. No circulatory system is needed to carry nourishment to various parts of the body because the digestive system accomplishes this task by its numerous branches. Digestion takes place both in the digestive canal and in

the cells lining it, and the undigested food leaves the body through the mouth—an anus not being present.

There are two longitudinal, coiled tubes which are connected near the head end by a transverse canal and open by two small pores to the exterior. These tubes give off smaller branches which end in large, hollow cells containing a number of cilia. This system is excretory in function.

Underneath the eye spots is a mass of nervous tissue called the brain, which gives rise to two lateral nerve cords connected by transverse paths.

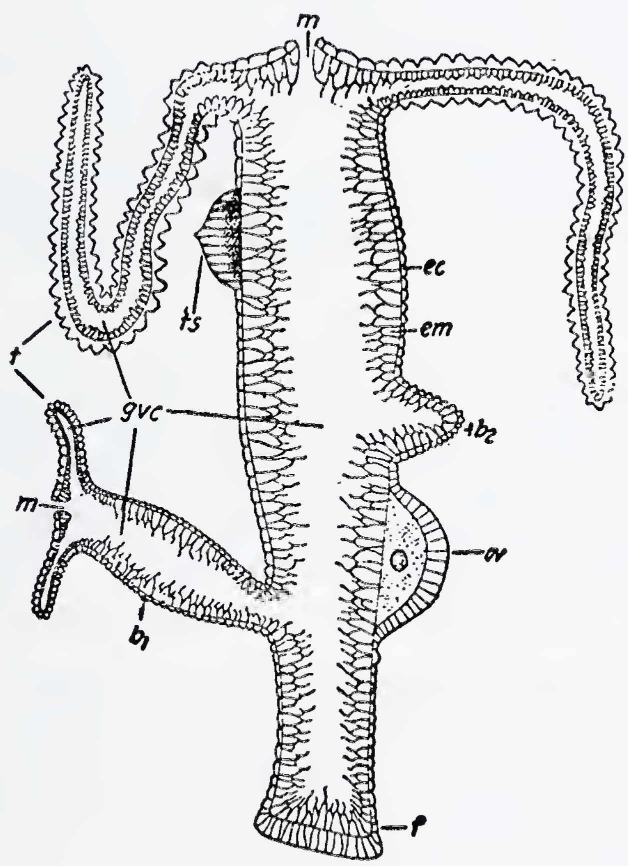


Fig. 4.

Hydra. Diagrammatic representation of a longitudinal section through the middle of the body showing ec and em, the two body layers; ts and ov, the reproductive organs; b1, b2, buds; m, mouth; f, foot; t, tentacle; gvc, central cavity. (Taken from A. F. Shull.)

The animal may reproduce itself by asexual division (fission) or by a sexual method.

Each Planaria possess elaborate sytems of male and female reproductive organs. As in the case of Hydra, the power of regeneration is highly developed.

UNSEGMENTED ROUND WORMS Mention must be made in passing of the microscopic, threadlike, free-living unsegmented round worms which are very numerous in sand and mud and which, under the microscope, remind one of miniature snakes by

the way they whip themselves about. It has been said that the number of nematodes in the top six inches of arable soil reaches thousands of millions. "Even the free-living soil and water nematodes (round worms) have become adapted to an astonishing variety of habitats; they occur in arid deserts, at the bottom of lakes and rivers, in the waters of hot springs and in polar seas. They were thawed out alive from Antarctic ice by members of the Shackleton expedition." [3] We must also remember that there are many nematodes which are parasitic, producing disease in man and other animals.

The plan of structure is as follows: The alimentary canal is a tube passing through the body and ending near the hind end in the anus. There is a nerve ring which passes around the esophagus probably being a rudimentary brain. The sexes are separate, and the number of eggs produced depends upon the species. The male of a species is often very much smaller than the female, shorter lived and harder to find.

WHEEL ANIMALCULES—ROTIFERS

Rotifers are a group of microscopic animals of variable shape found both in salt and fresh water, but principally in the latter. "Lakes, ponds and streams harbor them in immense number and variety. Swamps and marshes swarm with them. Wayside pools, drains and even the dirty water that stands in barnyard holes about manure heaps are prolific sources of rotifers. The mud of eave-troughs, the bottom of funeral urns, the cavities found in the axils of the leaves of certain mosses—all these are famous collecting grounds for the rotifer hunter." [3]

Their attractive appearance and interesting activities are always a source of delight to the microscopist. Because of their small size, they might be mistaken for protozoa were it not for certain definite characteristics. (Fig. 2.) At the head end of the body, there is a region possessing cilia in constant motion. By means of this motion which produces the effect of a rotating wheel to the observer, water touching the animal is changed and new oxygen supplies are thus obtained for the entire surface of the body to absorb. This is the manner in which respiration takes place. The currents caused by the beating cilia also bring food particles to the mouth and removes excretory products and carbon dioxide from the surface of the body. Lastly, ciliary motion may result in allowing free-swimming forms to place themselves into new advantageous relationships with respect to food—thus serving as locomotion organs.

The tail region is often divided into two parts and is able to stick to objects by means of a secretion from a cement gland which it possesses. (Fig. 2.)

The internal organization, too, is worthy of note, and we must marvel at the intricate systems that Nature has given these small forms. Food passes through their mouth into a chewing stomach which contains hard jaws of an animal substance called chitin. These jaws, by their movement in tearing apart or breaking up food particles, help us to identify a rotifer from other living forms. Food next passes into a glandular stomach, where it is digested. Feces pass through the intestines and out of the anus. Nitrogenous waste is removed from the body by means of very small tubes which pass through the body, empty into an urinary bladder which by its contractions forces the material out of the anus. A brain and certain nerves are present. (Fig. 2.)

The female rotifer is the important animal, and the male is usually a tiny, short-lived degenerate which lacks an alimentary canal. Rotifers may produce thin-shelled summer eggs which are of two sizes—the larger producing females and the smaller, males—and thick-shelled winter eggs which are fertilized and which develop females.

MOSS ANIMALS These forms are found living in colonies which spread out on sticks and stones or they may produce a crust and "others form solid jelly-like masses which in one species reaches the size of the closed fist and not infrequently surpass that." [3] Plant-like in appearance they represent many diverse interesting forms. Certain species have been found growing in water pipes in which they may materially reduce water flow.

Each individual of the colony has a structure somewhat resembling an adult rotifer. The digestive tract is U-shaped and the anus is either within or without the crown of ciliated tentacles which guards the mouth opening. In one group, the viscera is said to degenerate periodically, a new alimentary canal appears and the remains of the old passes through the gut wall and leaves the body through the anus. The food of the bryozoan is represented by smaller organisms such as diatoms which are drawn into the body through the mouth. Reproduction takes place in a number of ways. Each individual as a rule possesses male and female organs and in the marine forms, the embryos are free swimming. Sometimes internal buds are formed and enclosed in a

chitinous shell. Later on, these are set free and upon germination, each produces an individual which fixes itself and forms a new colony. These buds, therefore, act as organs which allow the species of bryozoan developing them to winter over, although some species that experience no cold conditions still produce them. They are also valuable, probably, in the wide distribution of the various species.

SEGMENTED ROUND WORMS

In reviewing the different types of worms found in water, it is necessary to remember certain aquatic relatives of the earthworm. These forms are found in the slime and mud on the bottom and along the shore of lakes, ponds

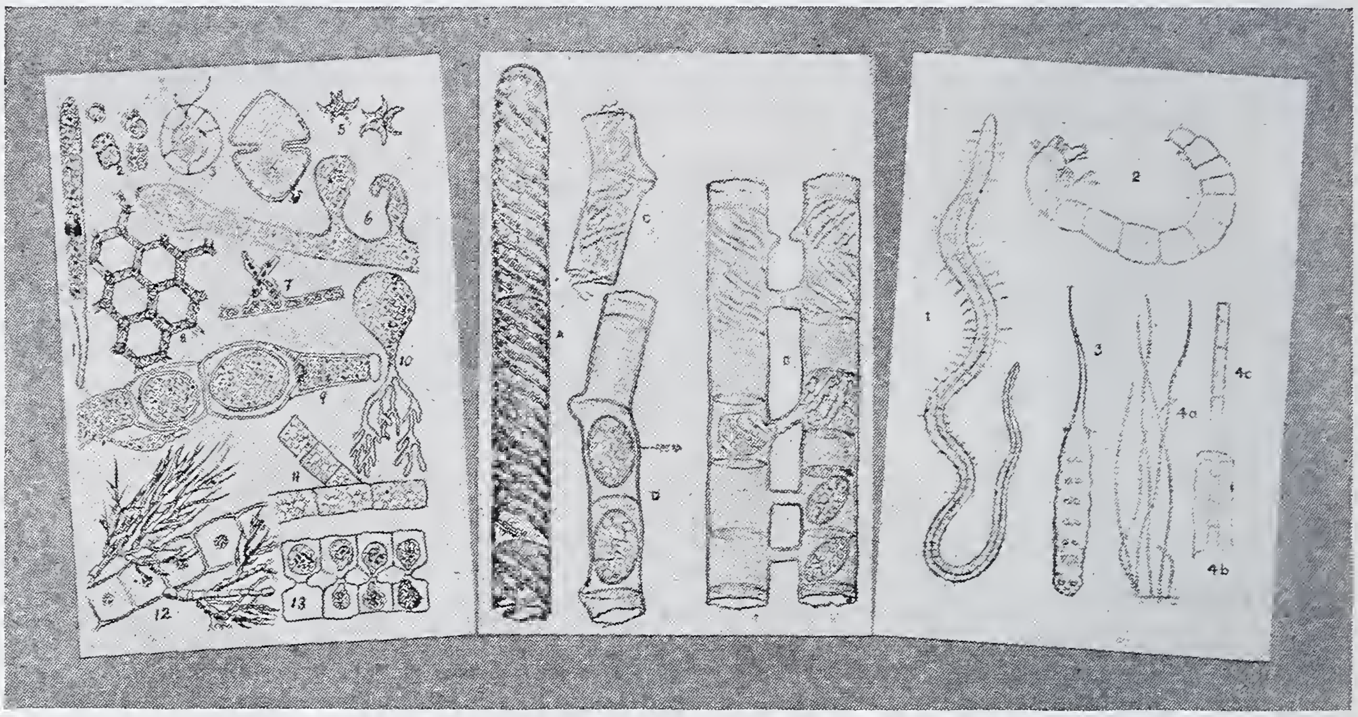


Fig. 5. Fig. 6. Fig. 7.

Fig. 5. Various types of Green Algæ showing both solitary and filamentous forms; 2, the green stain found on trees; 4, a desmid; 6, the green felt; 8, the water net; 13, conjugation in a filamentous form. (From H. W. Youngken.)

Fig. 6. Spirogyra. A, vegetative filament showing spiral chromatophore; B, filaments conjugating; D, zygosphores. (From H. W. Youngken, who took it from Gager.)

Fig. 7. "Type Organisms" found on the bottom of polluted streams. 1. Tubifex tubifex; 2. Chironomus plumosus; 3. Eristalis tenax; 4. Sphaerotilus natans; a. Tuft of filaments; b. Cells in both sheath and slimy envelope; c. Cells in sheath only. (From G. C. Whipple.)

and rivers and aid in the disintegration of organic matter which they use as food. Some species may be found where fermentations are numerous while others will not grow in polluted water. The segmented appearance of the body is characteristic of the group as is also the possession of a number of projecting bristles called setæ. It is not our intention to go into a more detailed description of the group but simply to refer to one form, Tubifex, which may be found in the

sludge along the bottom of polluted streams as will be discussed later. (Fig. 7.)

SNAILS

Snails are molluscs which are characterized by their one piece, spirally-coiled shell which protects the softer parts of their bodies lying within. The retractile head is provided with a pair of tentacles, at the base of which are the organs of sight. Below and under the tentacles, the mouth is located and the under surface of the body develops the fleshy broad organ of locomotion known as the foot. Snails live in both fresh and salt water and are often representative of some particular geographical region. Physa, Lymnæa and Planorbis are three common fresh water representatives.

CRUSTACEA

When we think of crustacea, we think of the crab and of the lobster, and thinking of these two animals reminds us that they possess pincers or claws. We visualize crustacea as sea animals covered more or less as a rule by a shell and which possess varying numbers of jointed legs used for pinching, walking, etc. However, although the animals just mentioned are representative of the group, it is well for us to remember that crustacea live in both fresh and salt water and also on land and as parasites and that many species are almost microscopic. Some forms are extremely numerous and it has been estimated that "on the average, each cubic meter of water in the small Wisconsin lakes contains about 40,000 individuals, and that 160 billion, weighing altogether about twenty tons, may exist at one time in a lake of eighty square kilometers." [2] Millions upon millions of small crustacea help to make up the population of the ocean.

Since we now realize that the individuals may vary so greatly, let us pick some small fresh water form, such as Daphnia, to study more in detail. (Fig. 1.)

Daphnia, the water-flea, is so small that although we are able to see it with the naked eye, we must put it under the big microscope in order to examine it intelligently. As we look at it, we realize that we are watching the activities of many systems of a complex animal. We see the eye moving, the legs kicking about and the dark colored food in the digestive tract passing toward the anus. The rapidly pulsating little bulb, above the digestive tract is the heart, and when we count the number of beats per minute, we find that it is far higher than in the case of the human heart. If the animal is

pregnant, we may even note the young fleas in the brood pouch along the back of the mother and see the life activities in the unborn young. Moreover, at the proper time, we may watch the almost transparent shell which covers the parent, open and witness the birth of the young water fleas.

Fig. 1 shows the anatomy of a mature Daphnia.

During spring and summer, female Daphnia are found, but with the approach of winter, males are produced which are usually smaller in size. Winter eggs are fertilized by the males before developing.

Another interesting fact concerning certain minute crustacea is that even though they possess such a complex structure, they may be eaten by some of the larger protozoa such as Stentor.

Two other well-known crustacea found in water are the small Cypris and the shell-less Cyclops, the latter possesses an eye in the middle of its head. The mother Cyclops can often easily be recognized by the long egg sacs she has attached at the rear of her body.

INSECTS It is not possible in a paper of this size to discuss the various insects commonly found in water nor even the classes of insects represented. For a detailed description, the reader should refer first to the chapter on Aquatic Insects in "Fresh Water Biology" by Ward and Whipple.[3] However, I do want to take this opportunity to mention Chironomus, a genus of midges whose larvæ are aquatic. The adult midge is a little mosquito-like insect but the larval stage of some of them is represented by a small, blood-red, worm-like form which is sometimes called a "blood-worm." (Fig. 7.) This color is due to hæmoglobin in the blood plasma. Gills are found at the end of the abdomen and the larva is able to live in various aquatic environments from shallow waters to deep lake bottoms. "Richardson has shown that certain species of blood worms (Midge larvæ, chironomidæ) prefer a strongly pollutional habitat while others are tolerant or indifferent and still others are confined to cleaner water." [4]

Having sensed by this brief review the complexity and diversity of the animal life found in water, we turn our attention to some common plant forms.

(B) *Plant Kingdom*

Plants may be divided into four large divisions—seed-bearing plants, ferns and their allies, mosses and related forms, fungi and algæ. We are interested in this paper in the last mentioned division whose

members are so simple that their body consists of more or less undifferented tissue—true roots, stems and leaves being absent. It is impossible to classify as either animals or plants certain borderline forms.

ALGAE Algæ have an intimate relationship to water. Some may thrive in damp places as on the sides of flower pots or trees, others cling to twigs and stones, partly submerged or are found free floating, and many dwell totally covered by the water in which they live.

The plants vary in size from mere microscopic dots to forms many feet in length, and in appearance from single rounded cells to

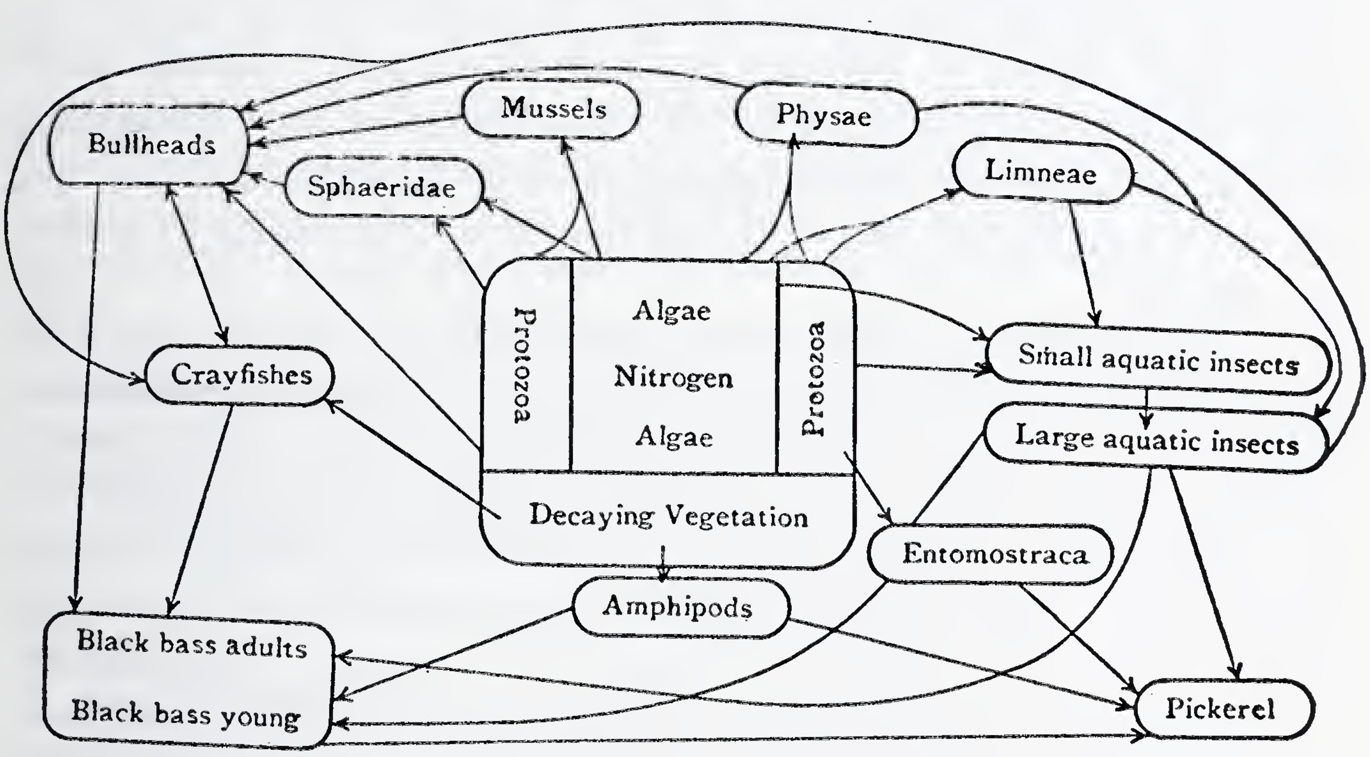


Fig. 8.

Food relations of aquatic animals. Arrows point to animal doing the eating. (From Ward and Whipple.)

long rows of cells (Fig. 5) or to sheets formed by the arrangement of filaments side by side. They contain the green pigment, chlorophyll, and therefore are able to utilize the energy of sunlight to build complex foods out of simple materials such as carbon dioxide and water. Reproduction varies in different members of the group, sometimes taking place by simple division of the cell into two new members or in other cases by non-sexual motile cells known as spores. In still other forms, sexual reproduction may be found. Algæ are divided by botanists into the following classes: blue-green, green, diatoms, brown and red. Of these, we shall deal with the first three mentioned groups since they are the forms found particularly in fresh water.

BLUE-GREEN ALGAE

The plants owe their color to two pigments found in their cells, green chlorophyll and a blue pigment, phycocyanin. The result is not a true green color, but a combinational effect such as blue green. It is said that in small bodies of water where blue-green algæ are particularly abundant, looking directly at the pond the water is reddish-brown, but when held to the light in a glass container it is blue-green.

Another peculiarity is that the cells in this group are without a definitely localized nucleus. Of course, it is understood that a nucleus is a denser protoplasmic body within the living substance of a cell. The cell wall may undergo modification and produce a mucilaginous sheath of varying thickness in the different species.

Certain of the blue-green algæ are responsible for the grassy odor produced in water in which they occur abundantly. Probably the worst offender or at least one of the worst offenders is the filamentous form called Anabæna which imparts an odor to water that has been variously described as that of fresh grass or of nasturtiums or even of the pigpen.

Oscillatoria is one of the common representatives of the blue-green group. It is a little filamentous form found growing abundantly on wet dirt in ditches, drains or on moist rock. It is often seen in examining pond water and is of great interest to watch under the microscope since the little chains of cells have the power of slowly gliding from side to side or oscillating. The individual cells are disc-shaped, except the terminal ones which are rounded. Reproduction is accomplished by the filament breaking transversely into segments, and each of these parts through growth and cell division forming new adults.

GREEN ALGAE

Perhaps you have noticed the green stain which is often abundantly found on the north side of trees, walls and fences, or perhaps you have collected from the sheer delight of plunging your hands in the cool waters of some little stream, the long green filaments you have found growing on submerged stones, or you may have experienced wonder when bathing at the seashore to see large masses like sheets of green rubber carried in by the waves and left upon the beach. These are examples of green algæ which are commonly known to all of us. Keeping them in mind, let us turn our attention to a description of the group.

Some green algæ are unicellular (and the cell may take various shapes); some form filaments (Fig. 5), others are sheet-like. The

plants are characterized by possessing the green pigment, chlorophyll, which may be present in a single or in a number of little bodies of various shapes, known as chloroplastids, found in the cell. A chloroplastid is a tiny body inside of the cell and contains the green pigment, chlorophyll. Now these containers of chlorophyll may be of various shapes—in some forms, spiral bands, in others, star-like, and in still others, little granules. It is due to the chlorophyll that the plants of this class are generally bright green—not the blue-green of the class of algæ previously described. In addition to the presence of pigment, the cells of green algæ are nucleated, *i. e.*, there is a denser place inside of the cell in which certain vital materials are brought together to form a definite body.

Reproduction may be accomplished either asexually or sexually. In the former case, spores which are asexual reproductive cells are produced by the parent body and later they are disseminated and give rise to new growths; or the parent body of the plant may divide into parts each of which is a new individual. Sexual reproduction takes place in the forms that possess it by one of two methods. (a) Two sexual cells of like nature called gametes come into contact and their contents unite. Later the body formed by the union of the two cells give rise to a new plant (Spirogyra) or (b) there is the union of two unlike gametes—the larger and passive one, the female, being fertilized by the smaller active male or sperm. (Vaucheria, the green felt.) The latter method is the highest form of sexual reproduction.

Let us briefly turn ur attention to certain specific examples of the green algæ and study them as representatives of the group.

Spirogyra (Fig. 6) is a green filamentous organism found floating in quiet water and is known as Brooksilk. A layer of mucilage on the outside of the filaments is responsible for their slimy feel. Seen under the microscope, each little green string is found to consist of cylindrical cells arranged end to end. In each cell, inside of the cellulose cell wall, there is a lining of protoplasm, and the nucleus is found at the center of the hollow cell supported by protoplasmic strands. Probably the most characteristic structures are the spiral green bands, the chloroplastids, which are one per cell in some species but in others as many as fourteen.

As the filaments of some species of Spirogyra get longer through growth and cell division, they break apart and become new individuals, each with the same propensities as the parent. Sexual reproduction

may be accomplished in the following way: Gametes or sexual cells are formed by the cells of two filaments which are lying side by side. Lateral bridges are developed between the two filaments by protuberances from the cells of one filament uniting with outgrowths of cells from the other filament. (Fig. 6.) Then the contents from the cells of one filament pass through the bridges into the cells of the other filaments where the gametes fuse in pairs. A heavy wall is secreted about the fused contents of the two cells (zygospore). The zygospore, when liberated, falls to the bottom and germinates after a period of rest to form a new Spirogyra plant.

But not all the common green algæ found in a drop of pond water are filamentous. Certain commonly found green algæ known as desmids may illustrate for us the unicellular forms, whatever the shape of the cell may be. The desmid cell (Fig. 5 [4]) consists of separate halves, semi-cells, connected by a bridge known as the isthmus which contains the nucleus. In some desmids, such as Closterium, there is no constriction of the cell wall, but nevertheless the contents of the cell are divided into two similar parts. Crescent-shaped Closterium is also of interest to us because at each end of the cell, there is a vacuole or space which contains tiny grains of gypsum which may be seen to be in constant motion owing to Brownian movement. Multiplication results in the division of the old cell into two cells, each of which was previously one of the semi-cells. New semi-cells are developed by each half. Sexual reproduction is accomplished by the formation of zygospores.

DIATOMS

Diatoms were once classified as protozoa because of the power of movement which some of them possess, and then later as algæ. They are found in both fresh water and the oceans where they furnish food for the larger forms of life. They occur as single cells and also as colonies, some free floating, others attached. Because of their abundance, their beautiful markings and infinite variety in shape and size, they interest and delight the microscopist. In size, they vary considerably from less than ten twenty-five thousandths of an inch to forms that are over one-twenty-fifth of an inch.

The general plan of structure of the cell, no matter its shape, is that of a pill-box. The siliceous wall consists of two halves or halves, one of which overlaps the other like the top of a box. It is therefore possible to have two distinct views of each diatom—one from the top or bottom (the valve view) and one from the side (the girdle view).

A central nucleus is found inside and a varying number of pigment bodies which give a yellowish brown color to the cell. Chlorophyll is present but it is practically obscured by a brownish pigment. Food is stored in the form of oil globules.

Reproduction may be accomplished by the division of the protoplasm inside of the cell into two parts, and then each mass, as the parent valves open, secretes for itself a new valve on the opposite side to the parent valve. The result is two new diatoms, each of which possesses one valve of the mother cell and one new one which it, itself, secreted.

Navicula, one of the fresh-water specimens, may be used to illustrate movement. Whipple [4] says that the motion has been described "as a sudden advance in a straight line, a little hesitation, then other rectilinear movements, and, after a short pause, a return upon nearly the same path by similar movements. The movement appears to be a mechanical one. The diatoms do not turn aside to avoid obstacles, although their direction is sometimes changed by them. The rapidity of their motion has been calculated to be 400 times their own length in three minutes."

The shells of diatoms have been deposited in enormous numbers on the bottoms of ponds, lakes, rivers, etc., over the course of the ages, and as a result large deposits of diatomaceous earths have come into existence. "One of the most remarkable for extent as well as for number and beauty of the species contained in it is that at Richmond, Virginia. It is in many places twenty-five to forty feet in depth and extends for many miles." [5] Purified Siliceous Earth, consisting of the purified fragments of diatoms, is of use as an absorbent agent.

FUNGI

The fungi are a large group of plants which lack chlorophyll and hence the power to make their food as do the green plants. They live, therefore, as saprophytes on decaying plant and animal remains or as parasites upon other living creatures. Certain of the fungi are unicellular and microscopic (bacteria and yeast) while others may be easily seen with the naked eye (mushrooms, puff balls, bread mold, etc.). The vegetative body of a fungus is known as a mycelium and the individual fungal threads which compose it as hyphæ. Reproduction is accomplished by fission, by budding and by various types of spores, and the various classes of fungi may be distinguished from each other by their methods of fruiting. In this paper we shall only discuss two groups of the higher bacteria which anyone analyzing water should know.

IRON BACTERIA

These are filamentous plants characterized by the presence of a gelatinous sheath in which may usually be found deposits of iron. Common examples of this group are Leptothrix, Crenothrix and Sphærotilus (Fig. 7), the last mentioned usually not having iron in the sheath.

Crenothrix is one of the most important inhabitants of pipes which carry ground water. It can oxidize certain forms of iron which it precipitates on its sheath and in time the carrying power of the pipe may be lessened by the growth of fungus and the deposits of iron. Crenothrix likes dark places, and thrives in iron-bearing waters containing but little dissolved oxygen. In appearance the filaments are unbranched with the sheath becoming brownish from iron oxide as the filaments get older. Whipple [4] cites instances of the harm done by Crenothrix.

"The 'water calamity' in Berlin first drew attention to its evil effects. In 1878 the water from the Tegel supply became filled with small, yellowish-brown, flocculent masses that settled to the bottom when water was allowed to stand in a jar. The odor of the water and the effects of the iron oxide in washing were decidedly troublesome. Crenothrix was not found in Lake Tegel, but was discovered in many wells, in the reservoirs at Charlottenberg and in the unfiltered water of the River Spree."

Sphærotilus (Fig. 7) consists of attached colorless threads. S. natans is often called the sewage fungus because it is found in polluted streams growing on rocks and twigs from which it is detached by the current and carried downstream.

SULPHUR BACTERIA

Sulphur bacteria are characterized by cells often containing granules of free sulphur, and are found thriving in the presence of that ill-smelling gas—hydrogen sulphide. Examples—Thiothrix and Beggiatoa. The latter consists of colorless filaments containing numerous granules of sulphur. It is of interest to note that these minute organisms are apparently able to build up complex organic foods from inorganic substances in the absence of light. One of the theories to explain this is that they obtain the necessary energy by oxidizing the hydrogen sulphide found in their environment. The reaction has been expressed thus:

$$2H_2S + O_2 = 2H_2O + S_2$$

hydrogen sulphide + oxygen = water + sulphur.

(B) *Seasonal Distribution of Microscopic and Almost Microscopic Organisms in Ponds and Lakes and Certain Factors Involved*

Our fresh waters may roughly be divided into those bodies that are relatively quiet, such as lakes and ponds and those in which the water is in constant more or less pronounced flow as in our streams and rivers. In this talk we shall study life in the former group, however, realizing that for both groups the factors involved are physical, chemical and biological, many of them the same, and that in the latter group, the streams and rivers, the noteworthy point is that floating organisms are subjected to a variety of problems due to the rapidly changing environment which do not have to be solved by dwellers in lakes and ponds.

At certain times during the year, organisms of one kind or another may be far more abundant in our ponds and lakes than at other times, and a study of the succession of these various groups and even of different genera within the group yields some very interesting results. Temperature, viscosity, density, light, food materials present and competition with other organisms are only some of the factors which are ever playing their part in the destinies of living organisms.

Water, as a substance, conducts heat poorly, but considerable quantities pass through it by convection. For every living thing, there is a range of temperatures throughout which it may survive. One end of this range represents the minimum or lowest, and the other end, the maximum or highest. Below the minimum and above the maximum, life, ordinarily is impossible for that organism. Somewhere in that range of temperatures throughout which the organism in question may live is the optimum—that temperature which the organism finds best suited to its needs. Since water temperature is constantly changing, it is obvious that this factor affects the lives of the inhabitants.

Viscosity which may be defined as the transient resistance of a liquid to deformation, opposes the sinking of those organisms whose bodies have a higher specific gravity than water itself. As water gets colder, its viscosity becomes greater and consequently the opposition it offers to sinking organisms greater. It has been claimed that certain forms adapt themselves to changing viscosity by enlarging their surfaces during the summer so that they will not readily sink too far. Daphnia hyalina is roundheaded in winter, pointed in summer.

As water gets colder up to 4 degrees C. or 39.2 degrees F. it gets denser and heavier and sinks. Below 4 degrees C. or 39.2 degrees F. the density again decreases. When water freezes, the density of the ice formed is less than that of the water at 0 degrees C., and hence ice, being lighter, floats. Let us apply these principles to the water in an average lake. Changes in the temperature of the water take place much more slowly than in the air above. As colder weather approaches, the surface waters become colder and denser and sink, displacing the warmer waters beneath and creating vertical currents that carry the organisms about with them. This continues until the surface temperatures proceed below 4 degrees C. and 39.2 degrees F. Then of course the surface water becomes lighter again though it is colder, and does not sink. Finally, when the lake freezes over, the water is stratified with the heaviest layers on the bottom and the lighter, colder layers above. With the approach of spring, conditions present themselves which are the reverse of the preceding fall. There is the spring overturn which may last for a few weeks. Later in the season the water again becomes stratified, but this time the warmer, lighter layers are at the top and the colder layers are at the bottom. Conditions vary in different lakes, depending among other things upon their depth. Some very deep lakes have no pronounced circulation; others very shallow have no stagnation except in winter.

Waters also exhibit the power of absorbing light. Whipple [4] states "Quiescent pure water transmits about 47 per cent. of the solar energy through the first meter of depth, 80 per cent. of the remaining energy through the one to two meter stratum, and over 90 per cent. through all deeper one-meter strata, the loss per meter rapidly declining to a minimum of about 2 per cent. of the energy incident on the upper surface of the stratum." It is to be noted that the amount of light absorbed increases as the suspended materials in the water increases. Green organisms need light in order to perform their life functions and hence are found in the upper layers. Certain organisms react negatively to light and seek the lower regions.

Living organisms must have enough of the right kind of food to grow and reproduce properly. Microscopic plant forms need, among other things, water, carbon dioxide, the chemical elements, nitrogen, phosphorus, sulphur, magnesium, calcium, potassium and iron in the form of available nitrates, phosphates and sulphates. Facts are present which lead to the belief that certain forms may use also organic food such as the amino acids, urea, etc. The food-making

operations of great numbers of green plants may reduce the available supply of carbon dioxide found in the water and increase the oxygen content beyond saturation.

Animal plankton, on the other hand, cannot live in general on inorganic food, but in order to exist must eat other plant and animal forms—living or dead. For example, rotifers may feed upon certain minute algæ and their distribution may be greatly influenced by the supply of this food. Figure 8 gives an idea of the complex food relationship between various groups of aquatic animals and of the struggle for life constantly taking place. A dominant group is one that finds conditions most admirably suited to its needs. The conditions are constantly changing and hence different forms may be dominant at different periods.

Let us illustrate the operation of the factors just mentioned by showing how they may co-operate in affecting the distribution of a certain group—the diatoms—in a moderately deep lake. These little plants appear during periods of complete vertical circulation of water. For example, in the spring, they are carried to the surface from the bottom regions by the currents created during the seasonal overturn. With them are also carried compounds which have been produced at the bottom under anaerobic conditions during the winter and which, oxidized by coming into contact with the air, yield suitable food for diatom growth. Therefore, diatoms now find themselves in favorable circumstances with respect to food, oxygen, temperature and light and as a result they multiply rapidly and soon great numbers appear. Later in the season, when the warming water becomes quieter, they sink into regions having too little light for growth and beyond a certain point they fall to the bottom to await another seasonal upturn. In the meantime another group of plants may have become dominant.

We now come to a few observations which have been made concerning the seasonal distribution of certain groups.

(1) Green algæ. Plentiful during summer. Like 60 degrees to 80 degrees F. in general.

(2) Blue-green algæ. Occur in greatest number a little later in the season than the green algæ, and enjoy a little higher temperature than the preceding group.

(3) Diatoms. Abundant in spring and fall in most ponds. Favorable temperatures for growth are found between 40 degrees and 60 degrees F.

(4) Protozoa. Seasonal distribution variable, those forms most like plants attaining their greatest growth in summer.

(5) Rotifers. Most numerous between June and November, although found throughout the year.

(6) Crustacea. Extremely variable.

(C) *Natural Agencies Involved in the Purification of Streams*

Streams flowing through centers of population are the recipients of industrial wastes and sewage. There is a tendency, however, in the stream for self-purification, using the physical, chemical and biological forces at hand. Let us illustrate this by the examination of a river that flows through a large town and study the changes that take place. Whipple [4] suggests the division of such a river into the following zones: (a) clean water, (b) degradation, (c) active decomposition, (d) recovery, (e) cleaner water.

Zone of Degradation. Just below the sewage outfall into a stream, the following changes take place: The water becomes turbid, shutting out the sunlight. Fish may feed on the fresh sewage masses in this region. Increasing numbers of bacteria cause decomposition and the supply of dissolved oxygen is diminished. Water fungi such as Sphærotilus and protozoa as Carchesium and Vorticella appear. The fungi form slimy masses clinging to rocks and stones, and being torn away, are carried constantly downstream. Green aquatic plants (algæ, etc.) find the environment progressively unfavorable and disappear. In the sludge on the bed of the streams, Tubifex or its brothers are found.

Zone of Active Decomposition. This zone is only found in heavily polluted streams in which the dissolved oxygen is almost or entirely used up. At the very middle of this zone, dissolved oxygen is nearly or quite absent and anaerobic bacteria flourish. The region is characterized by sticky black sludge with an offensive odor and by the evolution of gas bubbles. Carbon dioxide, ammonia and nitrites are present in large quantities and nitrates are found only in small amounts or absent. Fungi and Tubifex worms are not found in the septic portion of this zone, but sewage fly larvæ are common.

After the center of this region is passed, conditions assume a reverse trend. The amount of dissolved oxygen increases. In some rivers, this zone may extend for miles.

Zone of Recovery. The water gradually becomes clearer and the disagreeable odors disappear. The bed of stream is covered with

granular deposits rather than sticky sludge. From a chemical standpoint, dissolved oxygen increases as well as nitrites and nitrates. The number of bacteria is lessened and protozoa, rotifers and crustacea, green and blue-green algæ are present. Tubifex worms are also found in the upper reaches of the zone and fish are again seen.

Zone of Cleaner Water. Here appears the normal plant and animal life of the river as it was before it was upset by the sewage outfall. The purifying agents previously discussed are still at work. Water entering this zone is not yet in the state where it is free from disease-producing organisms and pleasing to the eyes and nose. Often, before these two qualifications are met, miles of flow are necessary. British bacteriologists have claimed because of this that there are no rivers in England long enough to purify themselves.

The above-mentioned zones are by no means definitely fixed and many causes may change their limits. New waste materials emptying into the stream, dams, and additional water from contributing rivers or creeks may alter the cycle of self-purification.

(D) *Conclusion*

It has not been the purpose of this paper to relate the methods man has used in his effort to control the growth of organisms found in different water-systems. The use of copper sulphate and chlorine to prevent certain growths and the various systems of aeration and filtration form interesting chapters in his endeavor to obtain intelligent control of his water supplies. If the reader, after the perusing of the foregoing pages is stimulated to look farther into the subject and to acquaint himself with the world of the microscope, to observe and to wonder at the marvelous diversity in life itself, and perhaps to add something of value to our information, then the object of the author of this paper has been accomplished.

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EVOLUTION OF THE MOTION PICTURE

By George Wesley Perkins

ANY ATTEMPT to establish a date exactly denoting the birthday of the motion picture is futile. Like all modern adjuncts of this advanced age, radio, aeronautics and others, an *evolution* or constant improvement and development has been necessary to bring them to their present status. Indeed, who can say that Sir Isaac Newton was the first to repose beneath an apple tree and discover the Law of Gravitation?

George Wesley Perkins

Shall we not therefore go back in history to our prehistoric ancestors? We find that one of man's first attempts to express himself was by means of pictures. In caves attributed to be of prehistoric times situated in various parts of the world, have been found crude drawings of animals. They are not motion pictures but represented a degree or phase of motion. Eons of time have passed since those pictures were made but it is only within the last sixty years that a series of continuous phases of motion could be shown. The motion picture is based primarily upon the evolution of several things, all of which are necessary to produce the motion picture. First, a device to "see" or catch the picture; second, a medium to retain the picture; and third, a device to reproduce or re-present the picture. Respectively we have the camera, the film or plate, and last the projector. These devices are the mechanical necessaries which, with a physiological action within the eye, of which we shall speak later, constitute the essential ingredients to produce the illusion which we call motion pictures.

THE CAMERA OBSCURA

The first camera was the *Camera Obscura* (from the Latin meaning a dark room). The first camera obscura was a room completely enclosed with an aperture at one side through which the light rays would stream projecting a picture upon the opposite wall. The principle of this crude

device was evidently first noted by Aristotle, for in his *Problemata* published about 350 B. C. he refers to the image of the sun reproduced by the sun's rays passing through a small square aperture.

In 1553, a remarkable work, *Magia Naturalis,* was published in Naples by Jean Baptiste Porta. Because of a passage in this work alluding to the camera obscura, Porta was popularly accorded the discovery or invention of the instrument. However, Leonardo da Vinci in some unpublished manuscripts gave a complete description of the camera obscura, which antedates the publication of Porta's. It is a far cry from the camera obscura of Leonardo da Vinci to the modern high-speed camera that can photograph a picture in a thousandth part of a second. There has been a simultaneous evolution or development of the camera and the device by which the picture is

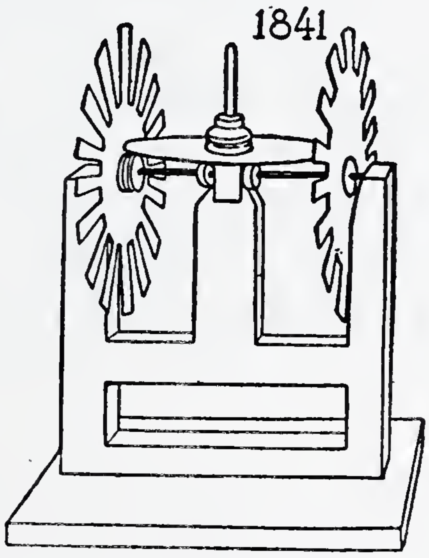


Fig. 1.
Device used by Faraday in Study of Persistence of Vision.

retained which we call the film. With the camera obscura there was nothing that would retain the image impressed on the inner wall of the camera. In our eyes the image impressed on the retina is transmitted to the brain by the optic nerve, and the brain translates the nervous excitation transmitted from the retina into its proper coördinated picture. Our memory retains the impression of the picture for future reference, when sufficiently trained to do so. In a film or plate, light rays coming in contact with the emulsion of silver salts with which the film is covered, excite or partially transform the silver salts so that upon *development* a picture is obtained exactly corresponding to the light rays received upon the film. The degree of excitation or transformation and subsequent development is in proportion to the amount of light energy received.

In the natural world the green pigment of the chlorophyll in plants is often in direct proportion to the amount of light received. If a portion of a green leaf is covered by an opaque object for a period of time an outline of the object would be seen on the leaf due to the loss of color in the unexposed portion of the leaf. Subsequent exposure to light without the opaque covering quickly restores the natural green color of the pigment.

A Frenchman, Joseph Niepce, discovered that bitumen of Judea or commonly known as "Jew's pitch," became insoluble in certain solvents after exposure to light. One of his best known prints dates from 1826. The bitumen was dissolved in oil of lavender and the bitumen unexposed was dissolved leaving a reproduction of the drawing. From some of the correspondence of Niepce we find that he made a photograph, using the camera obscura, and to Niepce is given a large amount of credit for the discovery of photography. The fact that silver salts darkened on exposure to light was recorded by Johann Schulze in 1727, the discovery being made in an accidental manner while conducting some chemical experiments. Many years later, Wedgewood and Humphrey Davy repeated the experiments of Schulze and further discovered that silver chloride was more sensitive than the nitrate. They made a number of pictures of various objects and published a joint paper in 1802 in the *Journal of the Royal Institution.*

THE DAGUERREOTYPE

Contemporary with Niepce was another Frenchman, Jacques Mande Daguerre, who made the first practical use and development of photography. Daguerre was by training a scenic painter and painted panoramic views for the theater. In producing some of his large scenes he used the camera obscura, which finally lead him to find some way by which the beautiful images of the camera obscura could be made permanent. Daguerre tried the methods of Niepce, Wedgewood and Davy and then used silver plates made sensitive to light by exposing them to iodine vapors. After exposing these plates to light he could not see any visible image, so placed them away in a cupboard. Some time later after taking these plates out of the cupboard to clean, he noticed an image on the plates that had developed during the time that they were stored in the cupboard. Upon further examination he found that some mercury had spilled on the floor and the vapor of this mercury had *developed* his plates. Because of this discovery and on the condition that he publish the method used and not patent it, the French Government

gave him a pension for life. The first attempts to make portraits by photography were made almost simultaneously by two Philadelphians, Dr. J. W. Draper and Robert Cornelius, in the year 1840. Dr. Draper made a portrait of his sister on March 31, 1840. This portrait, a daguerreotype as it is called because it was made by the method of Daguerre, is still in existence.

The invention of Daguerre stimulated other scientists to greater efforts in the development of photography. The production by William Henry Fox-Talbot of a sensitized paper with which he could make prints that were more or less permanent was practically co-incident with the work of Daguerre. Talbot's process which he called "Photogenic Drawing" was announced several months before Daguerre made public the details of his process. The introduction of glass for supporting the negative and the development of the collodion process by Frederick Scott Archer about twelve years later quickly obsoleted the work of both Daguerre and Talbot. The collodion process or the wet process as it was known was a distinct advance, although it had several objections. When an amateur photographer desired to go picture making it was necessary for him to take with him a heavy cumbersome outfit. Often a small donkey cart was used to carry the necessary paraphernalia, for it was necessary to prepare the plates just before use and immediately develop them after photographing the subject. The collodion process had a wide measure of popularity and some very good work was done while it was in vogue. However, the collodion process was finally supplanted by the gelatino-bromide process which with various modifications and improvements is the one used today.

We have briefly outlined for you the method by which we are able to retain a picture after we have photographed it. The device with which we take the picture known as a camera has kept pace in its development with the plate or film. The two essential parts of importance in a camera is the lens or "eye" and the shutter. In the camera obscura a tiny pinhole admitted the light rays to the interior of the box. Since the light rays entering the box are in proportion in quantity, to the size of the opening through which they pass, then the total light energy making up the image in the interior of the camera obscura is very small. As long as the pinhole opening is kept small a distinct image will be seen. As the size of the opening is increased the image will blur and finally be nothing but an even field of illumination. In the first case the rays of light entering the camera

from a single point outside the camera will reproduce that point at one place on the interior wall of the camera. As the pinhole opening is increased the points reproduced will overlap, causing blurring; finally all semblance of an image disappears. The chemical changes in the collodion or gelatine emulsion which on development produce the photographic image are in direct proportion to the light energy received during exposure: the light energy received is in proportion to the size of the opening through which the rays pass. With a pinhole camera (camera obscura) long exposure will produce satisfactory pictures, but when moving objects are desired to be photographed a minimum amount of time must be used and at the same time sufficient light energy must be impressed on the emulsion to cause the

Fig. 2.
An Amateur Photographer of Fifty Years Ago, Using the Wet Collodion Process. (From an Old Print.)

chemical change necessary for future development into a picture. In order to increase the amount of light energy received lenses were introduced. Their purpose is to increase the amount of light energy received without causing overlapping or blurring. The lens will focus the light rays so that a distinct image will be seen. Light as we ordinarily see it, white light, is composed of vibrations of various wavelengths of a substance which scientists at present have called "ether." These different vibrations correspond to various colors, because white light is really a mixture of colors. The "ether" vibrations are not all focussed in the same manner or degree by a single lens. By using a combination of lenses of various glasses a practically uniform focus-

sing of all of the various rays of light can be made. The development of the lens has been consistent with the evolution of the emulsion. In order to control the amount of light and the duration of exposure a shutter is necessary with the lens. Today shutter speeds may be obtained to better than one-thousandth of a second. In order to photograph extremely rapid motion, the discharge of a spark coil has been used as the source of illumination. The succession of sparks across a gap is equivalent to using an extremely rapid shutter opening and closing, for minute periods of time.

Almost everyone thinks of the eye as one of nature's most perfect instruments. We think we see what we see, but such is not always the case. A motion picture is apparently a natural appearing similitude of action in a continuous smooth manner with no disjointed motion. Our eyes tell us that such is what we have seen. Certain gentlemen of the sporting fraternity are often apt to say that the hand is quicker than the eye. On the screen the pictures are quicker than the eye, for in one second we see at least sixteen separate photographs, but our eye is not quick enough to register the successive changes. The sixteen separate photographs viewed in that second are superimposed by the eye, one above the other so that in our mind is registered a smooth course of motion or acting, with no perceptible jerking or jumping from one position to another. This phenomenon of *Persistence of Vision* which is the physiological basis of the preceding discussion can be expressed as follows: Our brain cells or the optic nerve and the retina of the eye continue to register the visual effect of light after it has ceased to act. Lucretius, about 65 B. C., expressed the fact of persistent vision in one of the books of his "De rerum natura,"—"This (perception of movement) is to be explained in the following way; that when the first image passes off, and a second is afterward produced in another position, the former then seems to have changed its gesture. This we must conceive to be done by a very rapid process," etc. In the second book of Ptolemy's Optics, written about 130 A. D., is mentioned the fact that if a sector of a disk be colored, the whole will appear of that color when rapidly rotated and if the sector be variously colored at different distances from the center, the disk will appear ringed. The average period of persistence ranges from 1/10 to 1/24 of a second, depending upon the degree of intensity, duration and color of the light received by the eye.

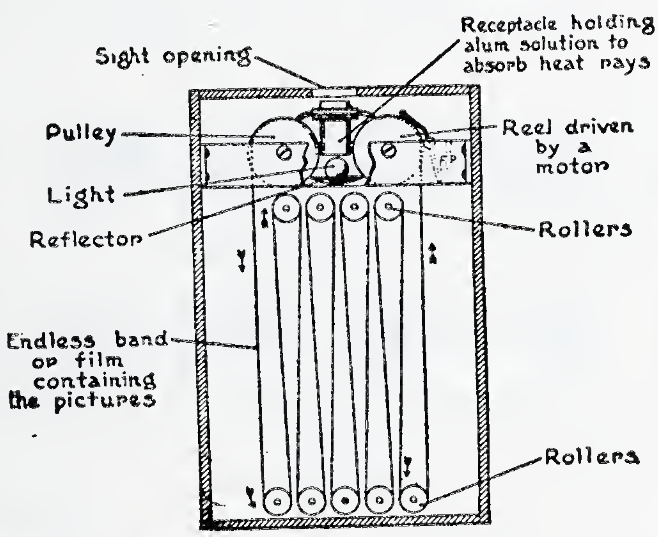
THE THAUMATROPE

The first application of this principle was in a toy invented about 1826 and called the *Thaumatrope.* It was a cardboard disk with two holes close to the edge at opposite points. Strings were passed through these holes and fastened and the dangling ends held and rolled between the thumbs and fingers so that the disk was made to twirl rapidly. Each side of the disk had a picture printed or drawn upon it. These two pictures when viewed together while the disk was twirled appeared as one complete picture, such as an empty bird cage on one side and a parrot on the other side. This device readily illustrates the phenomenon of persistence of vision. Pictures of both the empty bird cage and the parrot are superimposed on each other when looking at the twirling disk. Many scientists made experiments and constructed machines to illustrate this principle. One of the best known of these was the invention of a Belgian physicist, Plateau, who called his machine the Phenakistoscope. It was essentially a development of Faraday's wheel and consisted of a circular disk with slots cut in the edge. On the inside of the disk was pasted a series of drawings depicting various phases of motion, such as that of a dog running. At first the phenakistoscope was held in front of a mirror and when revolved the moving figures were viewed through the slots. In 1867 a United States patent was issued to William Lincoln, of Providence, R. I., for a toy called the zoetrope; the idea was not original with Lincoln, since Desvignes invented it first in France in 1860. All of these toys depended upon their novelty in the illusion of motion produced when they were revolved. Another device in use at this time was the praxinoscope of M. Reynaud, of France. He developed the toy by using mirrors and a lantern so that the moving figure could be projected on a screen. All of these devices used drawings to depict the phases of motion which were synthesized into the motion picture.

In 1861 Coleman Sellers, of Philadelphia, conceived the idea of using photographic prints to give a more lifelike appearance to these synthesized pictures. By the use of stereoscopic pictures of posed positions corresponding to successive degrees of motion he was able to blend these pictures in his machine into a lifelike motion picture. Sellers patented his machine on February 5, 1861, after considerable experimentation. When he first developed his idea the picture moved continuously without any intermediate cessation, but on further study he reached the conclusion that the picture must come to a stop for a brief period while the eye was looking at it. In his patent application he states: "After a long series of experiments, I made the

discovery that it is absolutely necessary that the picture should be entirely at rest during the moment of vision, or that the motion should be in the direction of the line of vision; that is, advancing toward the eye, or receding from it; just as you would take a card in your hand and move it from right to left or up and down.

The work of Henry Heyl, another Philadelphian, is of interest at this time. On February 5, 1870, Heyl exhibited at the Academy of Music a machine which he called the "Phasmatrope." Heyl's machine was a notable improvement over the *Kinematoscope* of Dr. Sellers. Heyl took photographs of different phases of posed motion of waltzers and acrobats; these photographs, eighteen in number, formed a complete cycle, so that the motion was repeated over and over. They were mounted on thin glass plates and the plates placed



PLAN OF EDISON'S FIRST KINETOSCOPE.
Modified from the Patent Office drawing.
Fig. 3.
(From Animated Cartoons—Lutz.)

around a wheel that was rotated by a crank and belt. The photographs were projected on a screen with the aid of a projection lantern (magic lantern). As the photographs came successively into view the light was cut off by a "vibrating shutter." The shutter caused the views to be seen on the screen momentarily in a stationary position. The shutter was moved by a ratchet and pawl on the axle of the wheel. The photographic plates could be easily removed and another set inserted. When the figures of the dancers were projected on the screen the orchestra played waltz music in time with the dancers.

It must be remembered that there was not at this time instantaneous photography as we know it today. Flexible film was also unknown at this time. The gelatino-bromide was just being developed

and was not yet in general use. Heyl had to use the collodion process for his photographs; this was not fast enough to photograph moving objects, hence the positions were posed in various degrees of the simulated motion. When synthesized on the screen the motion was distinctly lifelike. Heyl is to be commended on his synthesis of motion with the limited mechanical methods that were available.

In the next decade the development of the photographic emulsion and the camera was such that photographs of moving objects were able to be made. After Heyl there was no serious work on the synthesis and analysis of motion until the researches of Eadweard Muybridge. The institution of this research of Muybridge arose from a curious incident. Some California sportsmen, including Leland Stanford and James R. Keene, started an argument as to whether a horse lifted all four feet from the ground in horse racing. Stanford employed Muybridge to solve the problem; Muybridge

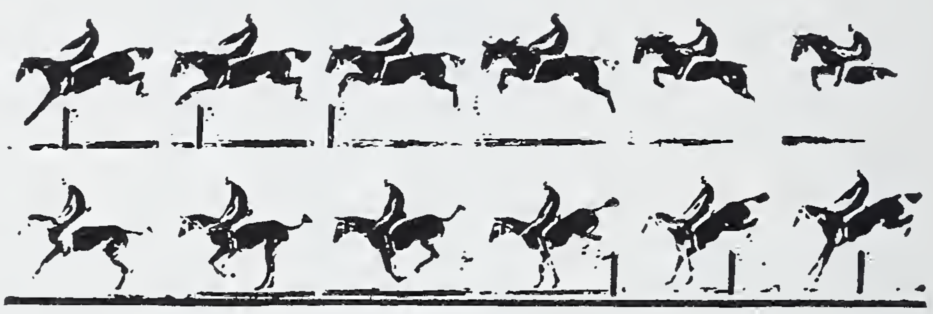


Fig. 4.
Muybridge's Experiments on Motion of Animals. (From Original Plates.)

was at the time employed as a photographer with the Geodetic Survey of the Government. He soon found after a few experiments that one camera was insufficient. He had to use the collodion (wet) process as the modern process was not sufficiently developed at that time. First he set up twelve cameras in a row and then twenty-four. The first photographs that were made blurred because of the slow speed of the shutter. In co-operation with John D. Isaacs, a graduate of the University of Virginia, of the engineering department of the Central Pacific Railroad, an electrical shutter was made for each camera. Strings stretched across the track and attached to each camera actuated the electrical shutters. A suitable background was used to obtain a good silhouette of the racing horse. In order to project these pictures on a screen Muybridge developed a machine very similar to that used by Henry Heyl. The revolving wheel was replaced by a single glass disk on which the photographs were mounted in proper order. The shutter was a second revolving disk

with a single aperture. An oxy-acetylene flame was used for the source of illumination and the lifelike photographs of the moving animals were shown on the screen. The results of his first experiments were published in 1878 and created intense interest among artists and scientists. The name of this new science as developed by Muybridge was zoopraxography, which is the analysis of motion by photography.

Muybridge exhibited some of his pictures at the World's Columbian Exposition in 1893, in what was called the "Zoopraxographical Hall." A large number of these pictures comprising more than thirty-five thousand photographs of animals, birds and human beings were made at the University of Pennsylvania under a special grant made by the Board of Trustees. Most of these pictures are in the hands of George E. Nitzsche, Recorder of the University, In conjunction with Dr. Edward Reichert at the University, photographs were made for the first time of the beating of a dog's heart. Today the motion picture is used extensively in medical research. Dr. E. J. Marey, a Frenchman, followed the work of Muybridge with an extended study of the analysis of motion. Marey's *Photographic Gun* is one of the first developments of the idea of a motion picture camera, and eliminated the twenty-four cameras of Muybridge.

THE FIRST FILM

In 1887, Edison began to become interested in the problem of motion pictures and soon realized the inadequacy of the glass plates and experimented with various kinds of films, principally films made from collodion varnish. In 1889 George Eastman developed the nitro-cellulose film base and established a factory in Rochester, N. Y. Mr. Eastman relates in a letter to the Society of Motion Picture Engineers his first contact with Mr. Edison. "While we were engaged in fitting up this factory I received a call from a representative of Mr. Edison who told me of Mr. Edison's experiments with motion pictures and how necessary it was for him to have some of this film. The idea of making pictures to depict objects in motion was entirely new to me, but of course I was much interested in the project and did my best to furnish him film as near to his specifications regarding fineness of grain and thickness as possible. As far as I know, the film we furnished him then and from time to time later was satisfactory. In the years during which the motion picture industry has been developed, we have made many improvements in the way of fineness

of grain, photographic quality and uniformity, but the film made today is substantially the same as the first film furnished Mr. Edison."

EDISON AND THE "MOVIES"

With the aid of this film Edison produced his kinetoscope in 1889. The machine was a small affair and only one person could view the pictures at one time. The capacity of the machine was also limited to about fifty feet of film, and the picture lasted about a quarter of a minute. The film was about an inch wide and contained sixteen pictures to the foot, which is essentially the same as used today. The problem of projecting these pictures on the screen was not solved until 1895. Thomas Armat and Francis Jenkins worked together on the problem in Washington, D. C., but after several disagreements Armat went to work with Edison and there produced a machine using some of the ideas developed in Washington.

Proper credit must be given to C. Francis Jenkins who gave what might be called the first moving-picture show as we know it today. Jenkins, while an employe of the Treasury Department, spent his spare time in developing a projector for the motion picture that would enable more than one person to view them at the same time. In 1894, in his home town of Richmond, Indiana, Jenkins showed a picture of a girl executing the butterfly dance that he had photographed in the back yard of his Washington boarding house. At the close of the show the people looked behind the screen for the dancing girl and could hardly be convinced that there was no trickery employed. Jenkins used a "beater" movement to give intermittent motion to his film, which was later replaced by the Geneva gear. Jenkins met Armat at this time and they formed a partnership to improve and develop the machine which Jenkins had named the *Phantoscope*. An application for letters patent was made on August 25, 1895, which was subsequently granted, to Jenkins and Armat. Their machine was exhibited at the Cotton States Exposition at Atlanta in 1895 and a disastrous fire there destroyed their only two machines. Jenkins went back to work in the Treasury Department while Armat, after some friction with Jenkins, went to work for Edison.

In Paris, on December 28, 1895, Lumiere exhibited his cinematographe, and in February, 1896, Robert Paul, of London, exhibited a projector modeled on the lines of Edison's kinetoscope. The machine developed by Armat in the Edison laboratories was put on the market as the vitascope, under Edison's name. On the night of April

23, 1896, this machine was given a public showing at Koster & Bial's Music Hall, in Herald Square, New York. The next fifteen years was a succession of patent wars, at the same time various alliances were formed and broken, followed by reorganizations, so that today the industry is principally in the hands of, or under the control of, a few large corporations. In 1926 the American motion picture investment was estimated at $1,500,000,000, which includes a world-wide distribution of films. Forty years ago Edison invested $24,000 in the process of developing the motion picture.

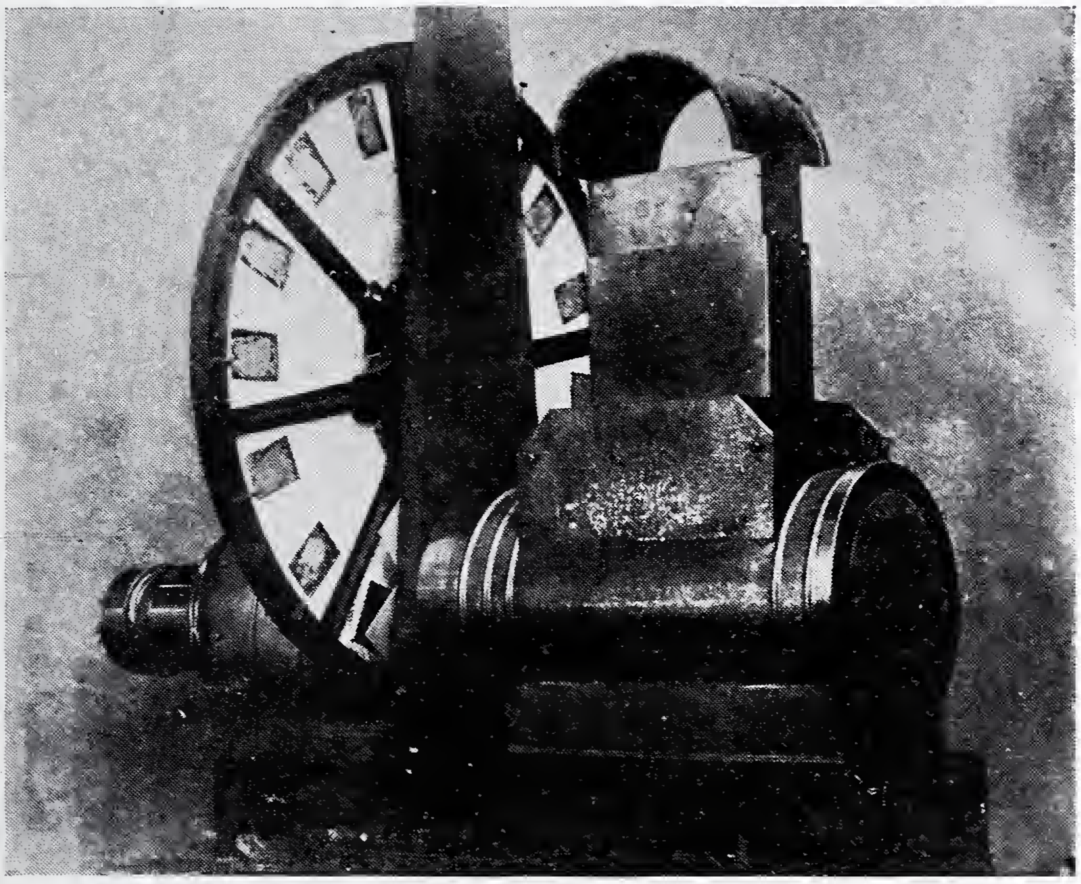


Fig. 5.

Views of Henry Heyl's Machine. (This machine is of historical importance and is in the hands of Prof. Charles Heyl of the West Philadelphia High School, to whom acknowledgment is due.)

Previously we referred to the first contact between Mr. Edison and Mr. Eastman during Edison's first experiments. The film which was supplied to Edison was negative stock. Film for making positives was not manufactured in the Eastman factory until 1895. The film output of the Eastman factory has increased from 21,663 feet in 1895 to over 200,000 *miles* yearly at the present time. A large quantity of the necessary raw materials, cotton and silver, are necessary for the production of this film. Over three tons of silver bullion per week is necessary to make the photographic emulsion. Next to

the United States Mint the Eastman Kodak Company is the country's largest consumer of silver. The silver is converted into silver nitrate by dissolving in nitric acid. The silver nitrate is mixed with potassium iodide and potassium bromide and then an emulsion is made with gelatin, of the silver iodide and bromide. This emulsion, after purifying by washing, is coated on the prepared transparent film base. The film base is principally nitro-cellulose and is made by treating cotton with nitric and sulphuric acid, a process which the chemist calls nitration. The nitration of the cotton changes it chemically so that it becomes soluble in certain kinds of solvents. The nitrated cotton is dissolved in the necessary solvents and a thick viscous liquid called "dope" is produced. This "dope" is converted by "coating" machines into thin flexible sheets three and one-half feet wide and 2000 feet long. These machines are accurate enough to produce a film with practically no variation in thickness in any part of the film. The gelatin emulsion is coated on these large sheets and after thoroughly drying and hardening the film, it is cut into strips one and three-eighths inches wide and from one hundred to one thousand feet in length. One type of film base in use for certain purposes is composed principally of cellulose acetate which is not as inflammable as the nitro-cellulose base and hence is called "safety film." This film is used in the home, schoolroom, lecture hall, etc., where the projector is not enclosed in a fireproof booth. Outside of its "slow-burning" characteristic the acetate film is not as satisfactory as the nitrate film.

Because of the highly inflammable nature of the film, definite precautions must be taken in handling and storing the reels of stock. Many fatal and spectacular fires have resulted from the lack of even ordinary precautions in handling the film. Municipalities early recognized the fire hazard attendant to the handling and storing of the film and enacted ordinances to safeguard against accident, but despite the activity of fire inspectors these rules are often flagrantly violated, with fatal results. The nitrate stock slowly decomposes at ordinary temperatures and gives off explosive gases; it will even burn under water when rolled up, because it supplies its own oxygen in the burning process. Official records show that film fires have originated in various ways; sometimes friction occurs in winding; occasionally a hot steam pipe causes ignition; often the careless smoker is to blame. One of the most dangerous results is the formation of the deadly carbon monoxide gas when the film burns in a confined space. The whole country was horror stricken recently at the fatalities of

an X-ray film fire in a hospital in Cleveland. The principal cause of the deaths was later ascertained to be the carbon monoxide produced from the burning film. In order to reduce the fire risk to a minimum the following precautions are necessary:

To Avoid Film Fires

(1) Have storage vaults properly constructed and amply sprinkled in accordance with the National Board's (Fire Underwriters') suggested regulations; exchange offices should also be sprinkled.

(2) Provide vaults with vents leading to the outer air; do not have vaults larger than experts consider safe.

(3) Install self-closing doors on vaults and keep them closed.

(4) Have all electric wiring in metal conduits; for incandescent lights in vaults, or those used for examining purposes, use vapor-proof globes (no extensions or alterations should be made without first consulting the local electrical bureau, and no unenclosed knife switches, or other arcing or spark-producing devices should be located in film storage or examining rooms).

(5) Prohibit smoking at all times.

(6) Maintain tidy premises, free from accumulations of film, packing materials and rubbish; good housekeeping is vital.

(7) Keep all reels in cans or shipping cases when not being examined or screened.

(8) See that reels are kept away from steam pipes and radiators, and provide latter with wire guards.

(9) Patching cements are flammable—handle them carefully, and keep containers closed when not in use; store reserve supplies in a safe place.

(10) Provide approved receptacles with self-closing covers for scrap film and litter; they should be emptied twice daily. Have a daily inspection made by a trusted employee.

(11) Keep supplies of posters and wrapping paper in a separate room cut off from the rest of the establishment.

In closing we feel that some mention should be made of the role of the motion picture in the educational life of our country. Numerous arguments pro and con have dealt with the problem of the value of the motion picture in education. Some years ago Mr. Edison

said that the motion pictures would "supplant textbooks within ten years." They will most probably never eliminate our textbooks but they are an important aid to the educator, a tool by which subjects of widely different latitude may be presented to the student in a manner that could not be attained by any amount of lecturing or reading. To a school boy who has never seen the ocean the motion picture can convey the idea of the waves and the beating of the surf that can not be obtained simply by reading from a textbook. Unfortunately some promoters have unloaded on the market films labeled "educational" that are absolutely useless to the educator. Such actions have, of course, caused a certain amount of disgust and unbelief as to the true educational value of the motion picture. A large number of the industrial films have considerable educational value in certain courses but direct advertising or propaganda is not wanted or discreet. In the field of science the motion picture is rapidly

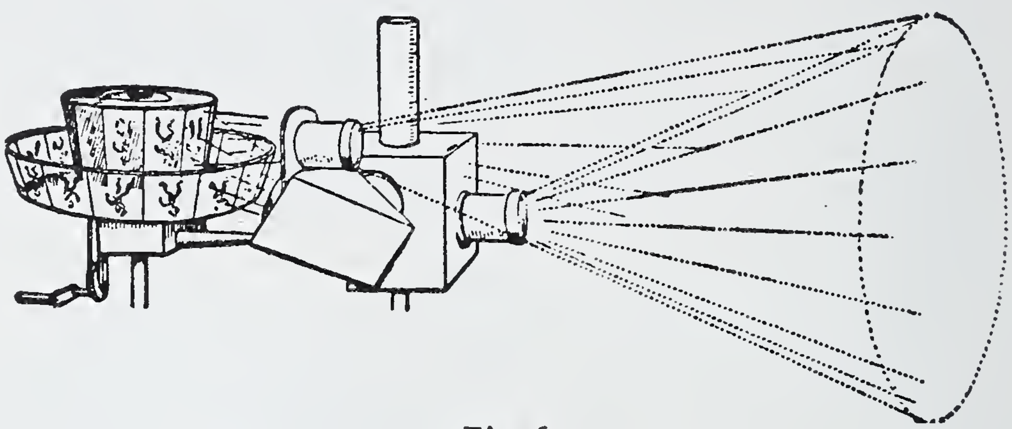


Fig. 6.
Reynaud's Praxinoscope. (From La Nature.)

attaining its true worth. From a number of sources a large amount of material of real worth and value for instructional purposes is available. In medicine a large number of pictures have been taken of all kinds of common and rare diseases that the student may view when otherwise only a chosen few would have the opportunity to observe the technique employed in the operation. Nelson L. Greene, editor of *The Educational Screen,* gives the following specific advantages of the motion picture in educational matters:

"It can be stated with some accuracy, from experience so far, that there are certain specific advantages of the motion picture film as compared with the other visual aids.

(a) The film is needed whenever motion is essential to full understanding of a given bit of factual experience.

The form, size and structure of a sea lion, for instance, can best be learned in the museum, in the laboratory, and from textbooks,

drawings and still pictures. But a few feet of film will show how that animal lives, moves and has its being in its normal habitat, thus rounding out the concept of a sea lion that could be completed in no other way than by a journey to the South Seas. Again, to thousands of inland boys who may never reach the shores of their own country, a complete concept of the ocean and its surf would be impossible but for the motion picture. The ceaseless struggle for existence that makes up life for the Eskimo could never be visualized adequately without a journey to the polar regions, until the great film *Nanook of the North* came. Examples could be multiplied at will.

(b) The film is the best visual tool when the continuity of a process involving movement is to be shown.

Industrial and manufacturing processes from raw material to finished product, the evolution of useful plants from the planting of the seed to the finished article in use by man, foodstuffs followed from their place of origin in any corner of the earth through all intervening processing and transporting until they reach our tables—such subjects by scores are already available in linear panoramas made possible only by the film.

(c) The film is advantageous for purposes of vivid summary or general survey of a broad topic.

A sequence in history, a topographical résumé of a region in geography, a comprehensive view of native customs and activities of a race or tribe in anthropology, a visualization of the actual physical backgrounds concerned in a work of literature, the concrete picturization of experiments, inventions or discoveries in science, the life and activities of an outstanding individual in any field of the world's work—these suggest an unlimited field that will be largely appropriated by the film.

(d) The film is unique for revealing for the first time in the history of human learning things which are too slow or fast to be seen by the human eye.

By the simple device of "stop motion" the film shows the germination of a seed, the opening of a flower, the development of fruit from the blossom. By the more complicated device of the speed camera we can know, by actually seeing it, how a water drop splashes, how an insect moves its wings, what really happens at the bursting of a shell, what a swinging golf club does when it meets the ball, and a host of other phenomena hitherto totally invisible.

(e) Finally, various inventions developed around the motion picture are enabling it to go beyond the realm of the concrete to some

degree, or at least to enrich vastly the ordinary photographic process as it was known previously.

Animated drawing and moving diagrams and maps are devices of vast possibilities, and they are practically perfected and ready for serious use. The theatrical field is rapidly developing other features for the film such as the synchronization of sound and speech with the picture (*talking movies*), accurate rendering of natural colors, the stereoscopic third dimension, X-ray and microscopic pictures, even the union of the movies with the radio when motion pictures can be sent through the air like the now familiar wireless messages in words (*television*). When these have been developed at enormous cost to the theatrical industry, educational films will steadily appropriate for themselves whatever will enhance their values in education.

As to the methodology of film teaching there is much to learn. Many teachers insist that a film serves best as a stimulating introduction to a new topic, which will call for and encourage further study of details. Others maintain that the film should be used only as a résumé following detailed study, with the purpose of co-ordinating and unifying a mass of data previously acquired piecemeal. This will doubtless be found to depend on various elements in the situation —the nature of the film and of the subject, the age and character of the class concerned, the immediate purpose of the course of study, etc.—and it is unlikely that films of many kinds will all lend themselves to one single method of use." . . .

Muybridge, during his experiments, foresaw the possibility of joining his motion pictures to the newly invented phonograph of Edison. He obtained an interview with Edison on February 27, 1886, and explained to him the new science of zoopraxography (motion pictures) as he had named it. Edison was interested in it but explained to Muybridge that he had at present no way of increasing the volume of sound so that the whole audience could listen at once. With the invention of the audion or vacuum tube by Dr. Lee DeForest and the concomitant development of speech amplification the practical possibility of synchronized motion and speech was recognized and several inventors applied themselves to the problem. DeForest, after the development of his photo-electric cell, was able to transform speech waves into electrical energy, which energy in terms of light waves produced corresponding lights and shadows in the emulsion on one edge of the motion picture film. A narrow beam of light, on passing through this narrow track of varying density in the emul-

sion, would fall on the photo-electric cell and then be transformed into corresponding electrical energy. Upon subsequent amplification the original speech waves would be reproduced. Other inventors have concerned themselves with the synchronization of speech, recorded on phonographic type plates, with the motion picture. Both systems have been successful and in the brief period of four years have developed from an experimental stage to an almost universal replacement of "silent" movies in this country. One of the first talking motion pictures made of a public official for exhibition and experimental purposes was on the White House lawn just before the presidential election in 1924. As is usual with him, Calvin Coolidge showed no curiosity when he made his speech at the time, although the invention was considered quite an oddity. "Talkies" and television are still in a state of evolution, the latter more so; we do not make any predictions for the future, but sincerely hope that the development of these two inventions will prove a material blessing to the more serious aspects of our life.

IODIZED SALT—A FOOD OR A DRUG?

By D. W. Horn, Ph. D.

Professor of Physics and Physical Chemistry at the Philadelphia College of Pharmacy and Science

IN RECENT YEARS a table salt known as "Iodized Salt" has made its appearance on the market. In some sections its sale is advanced by advertising propaganda directed, for the most part, along the lines customary in vending patent medicines, at times with the addition of some recommendation by the State or local board of health. The argument for the use of iodized salt is, as a rule, cogent, and bears no obvious suggestion of the fact that this cogent argument may be fallacious. In other sections of the country iodized salt is merely offered for sale and dispensed as any other grocery.

Two questions call for an answer here. First, why has iodized salt appeared here only in recent years? Second, in what sense may the argument recommending its use as a food be fallacious?

If we wish to know why iodized salt came into prominence within the last decade we must inquire into its nature and into the possible motive back of its introduction. Iodized salt may be defined as table salt (sodium chloride, $NaCl$), which, in the process of refining is made to contain a certain amount of potassium iodide (KI) or sodium iodide (NaI). A commonly mentioned proportion of iodine to chloride in domestic iodized salt is 1:5000. The market yields samples of varying composition, however, due to uncertainties in the preparation and to the gradual loss of iodine from some samples during storage. Since salt is said to be the second, that is, next to water, among the common articles of food, it may be surmised that in iodized salt the salt is merely a vehicle to convey iodides to the consumer. This surmise is correct.

The fact that you learned of iodized salt within the last decade in no way suggests, of course, the fact that in 1840 its use was started in Geneva, and later stopped by the medical profession, and that in 1859 the possibilities of harm from its use were unequivocably stated in medical literature. It was then, at that early date, set forth that one cannot watch too attentively the administration of iodine to people of forty years of age or over and that it is imperative to stop its use upon the first symptoms of saturation. The iodized salt there referred to

was 1 : 10,000, *i. e.,* one-half as strong in iodine content as our domestic article. Aside from iodized salts, precautions were urged as to the use of other iodine preparations as early as 1821—over one century ago—by the very advocate of their usefulness in the connection in which we deal with iodine tonight.

The first reply to an inquiry as to the aim in giving iodides would naturally be that it is probably done for some medicinal purpose. This reply is correct. Most of us are brought immediately to our feet upon considering this reply, for most of us are of the opinion that *medication involves individuality,* and is safe and satisfactory for us only when entrusted to someone in whom we have confidence, someone who knows our idiosyncrasies and who is at hand to observe the results and to modify the treatment in accordance with our requirements whenever necessary. This feeling on our part rests upon both prejudice and experience and is more intense when our offspring are involved. There is something too fundamental about this reaction for it to be ignored or quietly circumvented. I think it would be commonly regarded as prudent to deal in all such matters with the utmost candor.

Every medicinal procedure aims at disease. Sometimes it is a fight in the forward trenches where we look the enemy in the eye; sometimes it is a bombardment from a distance equal to the longest range of our guns, but naturally disease is always the enemy. Hence we are led to inquire as to what disease it is that is aimed at in the promiscuous dosing with iodides *via* iodized salt.

The answer is goiter—a disease of the thyroid gland, a disease resulting from the disturbed functioning of this gland. It is probably a fair statement that there are at least three diseases of this kind recognized. The first is that in which the gland atrophies and its functional activity diminishes. When this occurs in the early years of childhood it is congenital. Cretinism, as it is called, involves retarded mental growth as well as retarded physical growth, including retarded sexual development. Myxedema is another form of this thyroid disease, confined mainly to women of from thirty to fifty years of age. It is accompanied by a lowered metabolism, a loss of expression and of memory, a thickening of the skin and infiltration of a peculiar mucoid edema.

Contrasting with this first thyroid disease where the gland atrophies comes the second thyroid disease, where the gland enlarges and its functional activity increases. Exophthalmic goiter, as it is

called, involves a rapid heart beat and high blood pressure, tremor and nervousness, and protrusion of the eyeballs. In these two diseases the increase or decrease in functional activity of the gland is reflected in the so-called basal metabolism. Basal metabolism is measured in the laboratory by the heat production when the body has come to complete rest. The measurements are stated in calories per square meter of body surface. In cretinism and myxedema this number of calories is less than normal; in exophthalmic goiter the number of calories is greater than normal.

In addition to these two diseases of the thyroid there is a third, usually called simple goiter. It is accompanied by little or no general constitutional disturbance. It is non-toxic. The greater or less enlargement of the thyroid gland which accompanies it is usually regarded as probably compensatory for some insufficiency in the body-intake, and possibly for some changes during normal physiological body readjustments. It is at this third disease—simple goiter—that iodized salt is aimed. It is demonstrable that iodine can cause many simple goiters to disappear or to become reduced in size.

Inquiry as to why iodine may be expected to affect the thyroid gland leads us to the following circumstantial chain of thought: Iodine is a normal constituent of the thyroid gland. The true secretion of the thyroid gland is an iodine compound containing about 61 per cent. by weight of iodine. The chief function of thyroxin is to regulate the rate of metabolism. As little as one milligram of thyroxin given to a child will cause an increase of 2 per cent. in the basal metabolism. The normal healthy human thyroid gland contains about thirty milligrams of iodine. This is about 1/1000 of an ounce (apothecaries' weight), and amounts to approximately 4/100,000 of 1 per cent. of the weight of the human body (150 lbs.). Usually one to two milligrams of iodine are present per gram of gland. The iodine content of the gland shows a seasonal variation, the maximum occurring in summer or early autumn. When the amount falls below a certain minimum, enlargement of the gland takes place.

A train of reasoning is now within grasp. Insufficient iodine in the body-intake or an excessive daily demand may cause a thyroid disturbance. Conversely, a thyroid disturbance ought to subside if iodine is added to the intake. Just how such reasoning will command your respect may be shown by reference to Moleschott's famous saying. Upon discovery that there is phosphorus in the human brain he said, "No phosphorus, no thought." Now let us indulge ourselves

in a train of reasoning: Thoughtless people must be short in phosphorus; thoughtless people are a nuisance and a burden; therefore we will give all of us phosphorus. This will cure the thoughtless of thoughtlessness and insure the thoughtful of a very plentiful excess of phosphorus for their thinking. It happens to be true that we might relieve the thoughtless of all thoughtlessness, for phosphorus is a poison and all of us might, in the extreme cases, pass out of life together, by the same token. At least, with Hamlet, we might be said to be "sick of overthought."

This illustration is not strictly fair, for nothing is ever exactly like any other given thing, but it will suffice to illustrate how our thoughts in such matters may or may not deserve our confidence. At this point, lest you misunderstand your lecturer, let me say that this discussion tonight is not a theoretical one in the sense of being divorced from the practical aspects of the matter. Your speaker has for years been an ardent health worker and he is also one who must bear to his grave the unsightly scars of poisoning by iodized table salt,—for iodine poisoning may leave scars.

The next line of inquiry relates to the progress in knowledge of goiter which brought attention to it and to iodized salt. Goiter is a very ancient medical subject. It is said that the opinion that drinking water is the cause of goiter is at least as old as Hippocrates and Aristotle. The acid test of experience may be said to have been applied to this idea, since it is a matter of record, both in France and in Italy, that the drinking of certain waters has been resorted to in order thereby to gain exemption from military conscription. Goiter, common in a jail, has been seen to disappear when the drinking water has been changed. In the same village and under the same conditions of social life those who drank a particular water suffered, while those who drank another water escaped.

The case against water as a cause of goiter is commonly regarded as a strong one. During the military conscription in the United States for the World War data upon the prevalence of goiter was incidently made available. Upward of two million men from all parts of the country were examined physically; and when the results are classified by States for the prevalence of goiter, a striking picture appears. It can only be regarded as natural that the reaction would lead to some study of the water supplies of the States where goiter was more common.

It should also be made known to you that in the last century the learned Frenchman, Chatin, advanced the hypothesis that simple goiter is correlated with the low iodine content of the drinking water. The drinking water thus far examined throughout those parts of the United States shown by the World War draft to have higher incidence of goiter have proven to be relatively low in iodine content.

Prior to the war and since then quite a number of surveys of school children have been made and these furnish further data. The figures show varying incidence of goiter ranging from 9 per cent. to perhaps 55 per cent. Presumably the figures are not all equally convincing. In one instance about half of the cases of goiter reported were "very slight." Just what is a healthy enlargement of this gland and what is diseased enlargement, is still uncertain. However, there is no doubt that with advancing age, from early childhood on, there is a steady increase in the incidence of greater or less thyroid enlargement among boys, beginning at the age of six and reaching a peak between twelve and fourteen years, and thereafter showing a gradual decrease until eighteen years is reached. Among the girls the increase in percentage incidence of enlargement is steady from six to sixteen years. It should be borne in mind that one cannot consider one gland of the body, say the thyroid, without considering the others also, for it seems indisputable that the glands are interrelated and in some sense interdependent.

"The thyroid has some relationship to the sex organs, the nature of which is but poorly understood. . . . There is even an increase in size of the thyroid at puberty and during menstruation, pregnancy, and lactation." In the king scorpion the thyroid is said to be the organ of reproduction.

As to the normal sources of iodine for the human body one writer speaks of three, namely, the rocks, the sea, and the atmosphere by way of the sea spray. From this point of view parts of the country have been laid out geologically and it is postulated that iodine has been completely leached out of those parts, largely due to the Great Ice Age. Therefore, iodine will be lacking in these waters, and hence goiter will be common in these districts. It has been found by analysis that some of the waters of the southern states may contain upward of 18,000 times as much iodine as the waters of some of the northern states. Hence to some it would seem only necessary for us to take a geologist by the one hand and a bag of iodized salt by the other, and

by feeding the salt to everybody wherever the geologist directs, wipe out simple goiter.

The highest pitch of enthusiasm seems to me to have been reached when one earnest worker in this field in 1924 in the United States Public Health Reports stated that "It has also been recommended that the Board of Health (in Cincinnati) favor the enactment of a statute requiring the iodizing of all table salts in the United States, thereby insuring uniformity of the product and restoring to common salt one of the important ingredients which when naturally present, is invariably removed in the process of refining. A proportion of one part of iodine compound, such as sodium iodide, to 5000 parts of salt apparently satisfies the requirements."

This plan is so naive and simple that it reminded me of the statement I heard as a boy, made by an enthusiastic bishop in a lecture upon missionary work. He said, "We will Christianize China, if necessary, at the point of the sword"! As I say, I was only a boy, but I felt much the same as the editor of the United States Public Health Reports seems to have felt. He expressed himself in an editorial note as follows: "The amount of iodine recommended by the author cannot naturally be accepted as a definite and proper one for meeting normal human requirements. It may serve, however, as a point of departure for further observation and study, as a result of which more definite information may be obtained and a possible standard fixed. While the Public Health Service regards the use of iodized table salt for goiter prophylaxis as very promising, it feels that the establishment of a nation-wide standard will depend largely upon the practical demonstration of the harmlessness of the procedure and its demonstrated efficiency in preventing endemic goiter."

In 1925 a goiter survey was made of school children in Connecticut. Here is a saline State. If all is well with the philosophy beneath the naive and simple plan of iodizing us all with iodized salt then Connecticut should show scarcely any goiter. The sea is at hand, its spray blows over the State, and our geologist says he sees no reason why we need salt the citizens of Connecticut to save them. We tie up our bag of iodized salt and await the results of the survey, which results are a foregone conclusion, for our theory or hypotheses gives us in advance full knowledge of what to expect. We are in the position of those who associated the outbreak of diphtheria in Ireland with failures of the potato crop and who expected diphtheria the next time the potato crop failed.

In 1926 we read the report as follows: "There appears to be no correlation, in so far as the present study discloses, between the prevalence of thyroid enlargement and the principal geologic formations in Connecticut." At this point the *Journal of the American Medical Association* expressed itself editorially as follows: "Most of the so-called thyroid surveys among children of school age have been conducted in regions where a high incidence of endemic goiter might be expected. They have served for the most part to fortify the purposes of the advocates of prevention. A recent survey of 28 localities in Connecticut by experts of the United States Public Health Service indicates what may be expected in essentially non-goitrous areas. Accepting the iodine-deficiency theory of simple goiter causation, one would expect this State to show relative infrequency of thyroid enlargement; for the proximity to the seaboard and the excellent transportation facilities for readily obtainable sea food and other iodine-containing dietary articles, makes a serious deficiency in iodine improbable. In all, there were 2347 thyroid enlargements, a percentage of 18.9 among the 12,405 children examined. As usual, the incidence was decidedly greater among the girls. So far as the present survey is concerned there appears to be no section of the State of Connecticut in which endemic thyroid enlargement is more prevalent than in another. The figures quoted may be contrasted, for example, with the incidence of 58 per cent. in the Minnesota survey, or 33 per cent. in Cincinnati. There appears to be no correlation between the prevalence of thyroid enlargement and the principal geologic formations in Connecticut. The situation there is one that, in the opinion of the consultants, does not call for the institution of State-wide goiter prophylaxis through the use of iodized water supplies, iodized table salt, or wholesale distribution of tablets containing iodine."

Again, we read: "Whenever a new discovery is reported in the scientific world the danger of improper or unwise exploitation soon looms ahead. The realization of the importance of a supply of iodine for proper thyroid development and function presently encouraged all sorts of attempts to supply the lacking element, particularly in those regions where shortage might be expected to occur. As a consequence, iodized salt, iodized drinking water, and iodized foods of various sorts were offered for use and exploited with an ardor not entirely devoid of potential dangers of over-medication. There is not only a possibility, under such conditions, of ingestion of iodine in quantities that may actually be detrimental to some persons rather than

universally beneficial, but also the likelihood that the indefiniteness of such dosage methods may fail to secure the ideal therapeutic effects in persons actually in need of the material. Hence the *Journal of the American Medical Association* has tended to advocate methods of goiter prevention that involve definite dosage with iodine-bearing products of known composition rather than miscellaneous intake through specially iodized foods and drinks. The wisdom of this position has already been indicated by the occasional reports of ill effects from undue iodine intake."

The reasons for this editorial caution are many. First and foremost, iodine is a poison and iodism properly has its place in the science of poisons called toxicology. The sole excuse, if any there be, for assuming that 1 part in 5000 is too little to hurt is ignorance of whether it will harm or will not harm. The assumption could be urged only with a complete disregard of the warnings in the literature on the subject. Those of us who have been hurt have paid for our over-confidence in those who proposed the measures.

It is well to state that the iodized salt campaign in the United States superficially seems tolerable from the fact that the Swiss goiter commission of 1922 recommended an iodized salt; but you must know that the Swiss recommendation was for a salt only one-fortieth as heavily dosed with potassium iodide, that is, 1 : 200,000. In Michigan this amount was thought to be entirely inadequate, so the State Health Department assented to the larger amount!

The question of how much iodine is dangerous, I believe no one today could answer. Certainly if one is sensitive to iodine a most minute amount will produce a most marked reaction. The Philadelphian, Sajous, who perhaps deserves as much credit in this connection as any man because he spent his life largely upon the study of the glands, states in unmistakable English his opinion: "The nearer the individual approximates to normal health the greater are the chances of his developing iodism." Iodine is particularly dangerous because it is a cumulative poison. This has been demonstrated by experimental measures.

The data of the iodized salt campaign suffices in a sense to warn the reasonable. Apparently the minute amount of 23 parts of iodine per one hundred thousand million in the drinking water corresponds to an environment that suffices to correct the thyroid.

The untoward effects of the unrestricted use of iodized salt are just finding expression in the literature. We read from Detroit,

Michigan, an opinion by McClure: "From my analyses I conclude that the use of iodine promiscuously in table salt, in the effort to prevent simple goiter, may be harmful."

Again from Hartsock, of Cleveland, Ohio: "Both Dr. Crile and Dr. Phillips of this Clinic are deeply interested in the subject, and they agree with me that . . . the community use of iodine may produce, especially in adults, an incidence of thyroid disturbance of greater economic importance than the evil it is designed to abolish, and that the general use of iodine will never be free from danger unless it is supervised by the medical profession. . . . Community administration of iodine disregards physiologic facts. . . . The use of iodized salt, in particular, should be discontinued, or limited absolutely to periodic table use by children under the age of puberty."

And lastly, an opinion by Shelmire, of Dallas, Texas, who describes seven cases of acne of the face, all in women past the "acne age." These followed the ingestion of iodized salt (not prescribed by a physician in any instance) for a period of six weeks to one year. One patient, after being cured and temporarily discontinuing the use of iodized salt, returned for treatment after one year, consequent upon taking up again the use of iodized salt. A return to the use of ordinary table salt usually results in the complete disappearance of the eruption.

In the *Journal of the American Medical Association,* in response to an inquiry, the strength of iodized salt is given as 1 part in 10,000, but the product of one of the large salt companies, it is stated, contains 1 part of potassium iodide in 5000 of salt. The staff writer adds: "the indiscriminate use of iodized salt without medical supervision is, of course, not to be recommended."

It is not the purpose of this lecture to discuss the usefulness of iodine as a drug. If it is to be given to the expectant mother so as to prevent the birth of a cretin or of a child who will otherwise have a diseased thyroid, every sane man and woman will withhold criticism. If iodine mitigates certain other conditions, let it be used; but tonight we are interested in iodized salt as applied indiscriminately to populations . . . and at the point of the public health sword.

The outcome of the Connecticut survey showed that in a non-goitrous State, by the same standards used for goiter in surveys in goitrous States, there were 19 per cent. of the school children goitrous. One of the questions this result raises is, "When is a goiter not a goiter?", and we do not know who could answer it. "The size of the normal thyroid gland is not known." For this reason there remains

a question where the normal thyroid stops and goiter (abnormal thyroid) begins. Even when the normal adult size is theoretically established it must be considered that the normal adult sizes at different ages in various parts of the world are not known. Remembering the intimate relation of thyroid to sex glands, it seems indisputable that the normal size of the thyroid gland cannot be stated. Every one of us who knows the elements of statistics knows the outstanding weakness of statistics of attributes. "Where attention is paid to one attribute alone (only) two mutually exclusive classes are formed." "It may be noticed that the fact of classification by some investigator does not necessarily imply the existence of either a natural boundary or a clearly defined boundary of the two classes. The boundary may be wholly arbitrary." Each individual must be held either to possess the given attribute or not. "The division may be vague and uncertain; sanity and insanity, sight and blindness, pass into each other by such fine gradations that judgments may differ as to the class in which a given individual should be entered."

Aside from this question involved in any and every study of the statistics of attributes, including therefore, endemic goiter, a question we should ask is, "Does the proposed remedy, namely, iodized salt, applied to population correct the supposed evil, namely, simple goiter?" Here we must limit ourselves to experience in the United States, for the experience in Switzerland has involved the use of an iodized salt only a fraction as strong as that used in the United States. The proper experimental answer comes somewhat as follows: We make a survey of the school children, we apply the remedy for some time, and we make a re-survey. The re-survey should tell the tale. Such a re-survey has been made in Cincinnati after a term of three years. I quote from the U. S. Health Reports:

"The aggregate incidence of endemic goiter in 1927 was only slightly less than 1924. . . . It may be surmised that iodized salt was a factor in the slight reduction of goiter revealed by the 1927 survey. The total per cent. of thyroid enlargement among the boys in 1924 was 26.6, and it was 22.5 in 1927; among the girls 39.8 in 1924, and 39.3 in 1927."

Now we must remember in our analogy that we were reasoning about administering phosphorus, not only to cure the thoughtless but to insure an excess supply of phosphorus available to the thoughtful. In Cincinnati the re-survey does not, and of course, cannot show, how many or how few of the healthy were helped to remain healthy be-

cause they had an available excess of iodine for their thyroid at all times. However, we have already called attention to the untoward effects on normal adults. We freely grant a rational expectation of higher figures for goiter in children in States where the draft showed higher figures in men of military age . . . provided the same standard is used in classifying. But equality of standard would be difficult, for we understand "a military goiter" is such an enlargement as will prevent the wearing of a military collar. It would obviously be hard to fit military collars on boys and girls.

Assuming iodized salt to be the remedy correctly indicated for treating goiter and assuming it to be as weak and harmless as are most other patent medicines, we now ask where to buy it. Where can we get the needed remedy for this disease? In the drug store? No; to our surprise the answer is, "In the grocery store"! If we ask how it is that such a potent drug as potassium iodide is sold promiscuously and is allowed to come to every member of the family—in fact, is urged upon them by cogent advertisement—the reply is: It is a Public Health measure.

Public Health measures derive their force from the Police Power of the State. In matters not specifically covered by the constitution of the United States or by statute, this Police Power is controlled only by common sense, and upon appeal the courts give an opinion as to the reasonableness of measures carried on under it. The right to restrain you in your individual liberty when in the exercise of it you are a menace to others, is included in the Police Power. At times the use of the Police Power has been overdone.

Recalling our biological friend before we thank him and bid him good-bye (for he has served as a guide even if our quest has not led anywhere), we should learn from him of some other theories of goiter besides the iodine theory. It has been thought at various times that goiter was due to fluorine or to silica or magnesium salts, or magnesium and calcium salts jointly, or iron sulphide or copper sulphide, or some other metallic sulphide. Waters in limestone districts have often traversed metalliferous strata. Michigan and regions near the Great Lakes seem to illustrate this. Radioactivity has come in for blame for goiter. Recently the chlorination of drinking waters has been attacked as the supposed cause. A striking group of facts is that boiling water or heating it to 80° C. deprives it of goitrous qualities, while filtration through a Berkefeld filter does not.

The ill effects of iodized salt are double—those upon persons having hyper-thyroidism and those upon persons who are normal. Ill effects upon the first group we leave to the medical profession. Confining attention to the second group, since the problem here concerns populations, we have a few remarks to add. If Johnnie or Jane needs a dose of medicine during adolescence there seems to be no good reason why Father and Mother and Sister and Brother, and even Grandpa and Grandma, should take the same dose, particularly when danger attends the use of it because of its insidious effects. Too little is yet known to warrant a shot-gun procedure. Some States may be accused of dosing everybody with a medicine about which little is known, for a disease about which less is known, through the agency of some who may know little or who easily disregard what others thus far have learned.

SCHEDULE OF POPULAR SCIENCE LECTURES FOR 1930

Seventy Years of Petroleum

Wednesday, January 8 .... Professor F. P. Stroup

Sound—Production and Reproduction

Wednesday, January 15 .... Professor George Rosengarten

The Chemist as a Detective

Wednesday, January 22 .... Dean Charles H. LaWall

Heat and Cold

Wednesday, January 29 .... Professor Adley B. Nichols

Ventilation and Comfort

Wednesday, February 5 .... Profesor D. W. Horn

No More Pain

Wednesday, February 12 .... Professor E. Fullerton Cook

Iodine—The Element of Doubt

Wednesday, February 19 .... Professor Ivor Griffith

The Rat Menace

Wednesday, February 26 .... Professor Louis Gershenfeld

The Chemistry of Electric Lamps

Wednesday, March 5 .... Mr. Paul Q. Card

Dope—The Story of the Use and Abuse of Opium

Wednesday, March 12 .... Professor H. C. Wood

Transparent Life

Wednesday, March 19 .... Professor Arno Viehoever

Trees

Wednesday, March 26 . . . . Professor Marin S. Dunn

Inks

Wednesday, April 2 . . . . Mr. C. C. Pines

King Cotton

Wednesday, April 9 . . . . Mr. George Wesley Perkins

The Ultraviolet Lamp in Chemistry and Criminology

Wednesday, April 16 . . . . Dean J. W. Sturmer